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# The Role of the Chemist in the Processing Laboratory

By LLOYD E. WEST

**Photographic processing involves many individual chemical processes, such as assuring adequate quality of chemicals, determining optimum storage conditions for these chemicals before and after solution preparation, assuring the maintenance of standard chemical concentrations, and "trouble shooting." Illustrations are given showing how the principles of chemistry and chemical engineering applied to the processing of motion-picture film might result in low cost with high photographic quality of the products.**

A PHOTOGRAPHIC processing laboratory operates a series of controllable chemical processes. The chemical processes are those of the analytical methods, the preparation and storage of processing solutions, and the photographic processing. When these are properly controlled, the costs are at a minimum for acceptable quality products. The analytical laboratory plays a key role in controlling each of the processes. This paper treats only chemical matters and is not concerned with sensitometric or photographic control tests.

### Analytical Methods

The chemist establishes and operates the analytical laboratory. By use of his training he produces high-quality analytical results which are essential to chemical control of the processes. Analytical experience places him in the position of being sought to solve problems that require careful chemical judgment. The analytical laboratory operations are typically chemical in nature, not engineering.

The laboratory facilities which are required are dependent upon the number and types of processes operated, but there are minimum standards which are required to furnish reasonable guarantees of the analytical results.

Basic equipment includes an analytical balance which is used for preparing standard solutions, etc. Special volumetric equipment such as a 10-l volumetric flask is convenient for the preparation of large volumes of standard reagents.

Bench space is required for ordinary laboratory work such as titrations, extractions, etc.

A pH meter and a constant temperature bath are essential for pH control. A temperature regulating valve is used for adjusting the bath to a specified temperature.

A spectrophotometer is useful for making analyses employing the ultraviolet or visual region of the spectrum but is not required for the analytical methods used in some processes.

Bromide analyses require potentiometric titrations. These may be performed manually by the use of a pH meter. If many analyses are made routinely a recording potentiometric titrator may be advisable, thus eliminating the tedious manual titrations. The instrument draws the titration curve from which the inflection point is determined and the bromide content is obtained from an equation or table.

In addition to conventional analytical laboratory equipment certain special items may be used for convenience. Tip-up pipets* may be used in place of graduated cylinders.

The analytical laboratory should use methods of analyses which have proved to be reliable. Film manufacturers may supply such methods. Strict adherence to the methods, including the preparation of the reagents, is essential for control. The chemist can determine which analyses should be run and at what frequency.

**Table I. Processing Solution Variables Used Frequently for Control.**

| *Concentration of:* |
|---|
| Alum |
| Benzyl Alcohol |
| Bleach constituents |
| Bromide |
| Developing agents and decomposition products |
| Formalin |
| Residual hypo in processed film |
| Silver |
| Soundtrack developer constituents |
| Sulfite |
| Thiocyanate |
| Thiosulfate |
| *Nonspecific variables:* |
| pH |
| Specific gravity |
| Total alkalinity |

Variables that are used frequently for control are shown in Table I. Analytical methods are available for the determination of each of these. The measurement of a nonspecific variable such as specific gravity, pH, or total alkalinity is useful to detect an off-standard condition in a processing solution even though none of these variables can be used to determine the concentration of any single constituent.

The specific gravity is determined rapidly by the use of a hydrometer, and is particularly useful to check fresh processing solutions for the accidental omission of an ingredient, for a gross weighing error, etc. Tolerances of $\pm 0.002$ specific gravity units can be attained. If a result falls outside these tolerances, the chemist must search for the cause.

The pH of most developers is critical and requires careful control, tolerances of $\pm 0.05$ pH units sometimes being required. The utmost care must be taken in the preparation and use of the standardizing buffer. In order to attain the re-

Presented on October 5, 1955, at the Society's Convention at Lake Placid, N.Y., by Lloyd E. West, Color Technology Div., Eastman Kodak Co., Rochester 4, N.Y.
(This paper was received on January 27, 1956.)

* Available from Consolidated Vacuum Corp., 1775 Mt. Read Blvd., Rochester, N.Y.

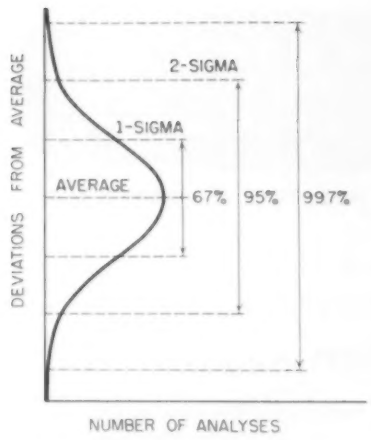


**Fig. 1. Frequency distribution.**

quired control of pH measurements, special care must also be used with the pH meter and electrodes. Temperature control during the pH measurements is also essential. An increase of 5 F lowers the pH of some developers more than 0.05 pH units.

The total alkalinity of a processing solution is an index of the total amount of alkaline materials present. It includes any sodium hydroxide, sodium carbonate, or sodium sulfite that is present. Deviations from standard of a fresh processing solution may indicate errors in the mixing, or the use of substandard chemicals.

The listing in Table I is not intended to be complete, but rather illustrative of the services that can be made available from an analytical laboratory.

Maintaining control of analytical methods is a quality control problem. Each analytical method has a number of potential variables, several of which may be changing as the method is repeated. However, if a method is applied repeatedly to samples of the same solution, the results can be expected to follow a normal distribution curve. This curve can be characterized as shown in Fig. 1. The greatest number of results will be found to fall near the average value. Deviations from the average may be expressed in terms of the standard deviations of repeat analyses using the method. *Sigma* is the term used to represent the standard deviation. According to the normal distribution curve, by definition, 67% of the results will fall within $\pm 1\sigma$ of the average value. Ninety-five per cent of the results will be found to fall within $\pm 2\sigma$ of the average value and 99.7% of the results to within $\pm 3\sigma$.

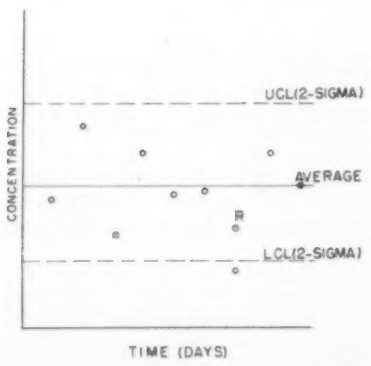


**Fig. 2. Control chart for standard sample.**

Figure 2 illustrates an application of a control chart to a given analytical method. A single batch of a processing solution is prepared and placed in many small, full, rubber-stoppered bottles. Bottles may be analyzed at any time as an insurance measure to check the method. The variability which is found includes that due to the equipment, the reagents, the analyst, and the inherent variability of the method itself as applied to the particular standard sample. The upper and lower control limits, denoted as UCL and LCL, are selected at the 2-$\sigma$ limit. The use of 2-$\sigma$ limits means that if no trouble exists, 95% of the time a result will fall within the control limits, and 5% of the time a result, by chance, will fall outside the limits. Thus, if a result falls outside, a repeat analysis is run. If no trouble exists, again the chances are 20 to 1 that the repeat analysis will fall within the limits. If, however, the repeat analysis falls outside the limits, the cause of the trouble should be sought. The chemist and anyone else using the results of a given analytical method should have access to a control chart as a quantitative measure of the precision of that method.

It is also important to know whether an analytical method is biased, that is, whether the average of the results obtained by its use is equal to the true composition or whether the results are higher or lower than the true composition. The magnitude of any bias may be found by analyzing samples of known composition.

### Preparation and Storage of Processing Solutions

The proper selection of chemicals can prevent processing difficulties. The most widely used chemical is water. Fortunately, most municipal water supplies are of suitable quality for photographic processing. Hardness may cause turbid mixes or turbid wash waters which, in extreme cases, may result in spots on the product. The addition of a sequestering agent to the mixes may eliminate such trouble. Traces of copper ions are objectionable but fortunately copper ions are rarely found in concentrations high enough to be troublesome. Copper lines for water supplies are satisfactory because no appreciable amount of the copper dissolves. On rare occasions a municipality may add a copper salt to the municipal supply to prevent the growth of algae. Copper ions in a developer may produce fogging. Copper ions also catalyze the decomposition of a developer that is exposed to air. The amount of iron generally present in water supplies is not objectionable from a photographic standpoint, but may produce turbidity in mixes.

The American Standards Association has issued specifications for approximately 60 chemicals that are used in photographic processing. The chemicals are referred to as photographic grade because the specifications were formulated on the basis that the purity of such chemicals is satisfactory for existing photographic processes. Chemicals of that quality are available in the trade. Chemicals may or may not carry a label stating that they are of photographic grade.

Whether chemicals such as USP, Technical, CP, or Industrial Grade are acceptable for photographic processing can not be determined merely by noting the grade. However, the manufacturer's specifications or the analyses of the material can be compared with the specifications set forth by the American Standards Association. An Index to the specifications, as well as the individual specifications, is available from the American Standards Association, 70 East 45 St., New York 17, N.Y. The test methods for the chemicals are included in the specifications.

The chemist may be asked to decide upon the use of a substitute chemical in cases of short supply or in cases of more favorable economics. For example, a pound of sodium bromide contains 15.5% more bromine than a pound of potassium bromide. Current prices of the two chemicals are approximately the same. Either may be purchased to meet ASA specifications. Both salts have satisfactory keeping characteristics. Prices and availability may be used as a basis of choice.

The chemist may also consider the use of photographic-grade anhydrous sodium carbonate rather than the use of sodium carbonate, monohydrate. The amount of anhydrous material required to yield a given amount of carbonate ion is 14.5% less than that of the hydrated material, and the anhydrous is less expensive per pound. Keeping characteristics of the anhydrous material are satisfactory for at least nine months in export-type bags which have a moisture-proof barrier. The anhydrous material is available from various manufacturers. The dense, coarse, granular product flows easily from a bag.

The preparation of photographic processing solutions is generally a chemical as well as a physical process. The amount of water used at the beginning of the preparation, the temperature, the sequence of the addition of the chemicals, and the rates of addition, may all play a part in the quality of the resulting solution. Developing solutions are subject to

**Fig. 3. Cross section of mixing tank.**

oxidation, and therefore the technique of mixing should minimize aeration of the processing solution. The mixing tanks should be made of Type 316 stainless steel. The ratio of the height of a tank to its diameter should be approximately 1.5 to 1. The tank should have four baffles arranged as shown in Fig. 3. Each is approximately one-tenth the diameter of the tank. The mixer is mounted above the tank over the exact center. The impeller is approximately one-third the diameter of the tank. It should turn at no faster rate than needed for rapid dissolving of the chemicals. The arrangement eliminates vortexing and excessive aeration at the surface.

After a processing solution is prepared, it may be transferred to a storage tank in order to free the mix tank for use in preparing another processing solution of the same, or of a different, composition.

In order to determine the optimum size and the design of a storage tank, the rate of use of the solution and its chemical stability must be considered. Ideally the chemical composition of a processing solution should be kept constant during storage. This can be virtually attained for some solutions by storing them in a stainless steel tank with a floating cover of stainless steel. The cover may be a sheet of steel with a 3-in. raised edge around its circumference. A handle may be welded on it for convenience. The cover prevents loss of water and other volatile constituents and prevents the absorption of carbon dioxide and oxygen from the air. The concentrations of some ingredients of a processing solution in an open tank increase with time owing to the evaporation of water or other volatile ingredients, whereas the concentrations of other ingredients decrease with time, if they are subject to oxidation.

A laboratory experiment may be performed to determine the extent of the improvement in the stability of a processing solution stored without access to air. A portion of the solution to be tested is placed in a large open beaker or graduated cylinder. Some of the same solution is put into several small bottles, filled to the top, and tightly stoppered with rubber stoppers. The samples in the full stoppered bottles simulate the solution stored under a floating cover. The samples in the open and closed containers are then analyzed periodically, for example once daily, for the ingredients. It is important that a bottle not be restopped after a sample is removed in order to use the remaining portions later for another analysis because the air in the top of a sample bottle simulates an open container rather than a storage tank with a floating lid.

Stability data may be practically applied to find out how long a processing solution may be stored, under any specified storage conditions, before the least stable constituent will change in concentration from its standard value to its predetermined tolerance limit. That time limit may be referred to as the useful life of the solution. Predetermined tolerances can be set by knowing how critical the various constituents are photographically.

Figure 4 illustrates the effect of a floating cover upon an Eastman Color Soundtrack Developer. By examination of such analytical stability data, the chemist may establish the most economical storage facilities which assure his required quality of processing solutions.

It should also be pointed out that the change in the concentrations of some constituents in an open tank takes place very rapidly when the tank is nearly empty because of the increase of surface area per unit volume of the processing solution. Figure 5 indicates the rate of increase in the surface-to-volume ratio as the volume of the solution is consumed during usage. Analyses may indicate the advisability of dumping the last 5% of the processing solution, if stored in an open tank, if some of the constituents are readily oxidized by air.

### Photographic Processing

The primary types of chemical processes to be controlled are those of photographic processing. The chemist is in an ideal position to appraise the economics of operation insofar as chemical cost is concerned. Cost should not be divorced from quality, but it is difficult to assign numerical figures to quality.

It is obvious that in batch operation each successive roll or area of film is subjected to a different chemical environment than the preceding roll or area. Continuous processing which employs the constant input of a replenisher may be used to reduce chemical variation with time.

When a new process is installed, or when a single chemical change is made to a given process, it is helpful and often necessary to determine the new operating level of one or more chemicals. At such times it is important to know the amount of bias of an analytical method.

Chemical changes in a processing solution during aging over a weekend are different from the chemical changes occurring during processing. Getting a process into control on a Monday morning may be hastened by use of chemical control. The analytical laboratory can determine the rate of deterioration of the various chemicals measured over several weekend shutdown periods. From such data suitable chemical additions may be determined for Monday morning start-ups.

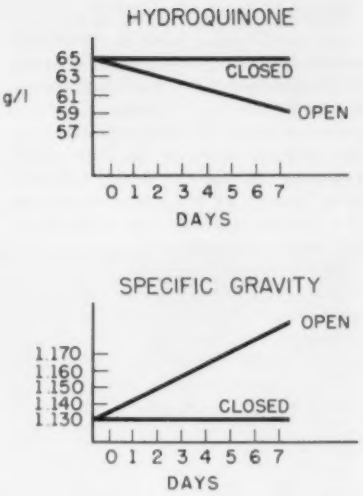


**Fig. 4. Effect of floating cover on stability of Eastman Color Sound Track Developer.**

It is seldom that adjustments of mechanical conditions such as temperature, agitation, etc., can be used successfully to compensate completely for off-standard chemical conditions. The use of a mechanical variable to compensate for an off-standard chemical condition may lead to more mechanical adjustments to compensate for new abnormalities brought into the process by the original mechanical change. Such a chain of events may soon result in a process being "lost in the woods" instead of being brought under control. The statistical nature of the control problem has been described by A. M. Koerner.*

* Allan M. Koerner, "The problems of control of the color photographic processes," *Jour. SMPTE*, 63: 225–230, Dec. 1954.

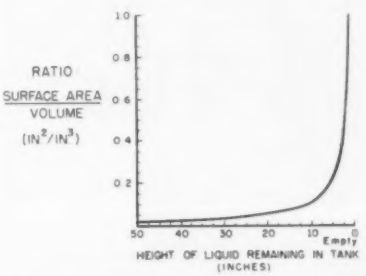


**Fig. 5. Liquid surface-to-volume ratio for a storage tank of 4.5 ft height and 3.0 ft diameter.**

Routine analytical control is used as a check upon conformance to established standards. As long as a process is within established tolerances, analytical control is only an insurance measure. The frequency of analytical testing should therefore be established on the basis of the frequency of the particular chemical being outside of acceptable tolerances. The economics of insurance is inherently difficult to evaluate.

In cases of diagnosing processing troubles, the chemist may become the most important person in the processing laboratory. In time of trouble, the chemist is sometimes expected to have analyses that are subject to no error, and to be able to pinpoint the trouble, leaving no doubts in anyone's mind. The extent to which he can fulfill such requests depends to a large extent upon his operations prior to the time of trouble. For example, in case of trouble, it is often extremely valuable to have information which can be collected only over a long period of time and which was not needed prior to the emergency.

If on occasion the chemist does nothing more than to prove that the difficulty does not lie in the realm of chemical control, that information may be extremely valuable in the further search for the cause of difficulty.

**Discussion**

*Garland C. Misener (Ansco)*: In those few instances when second or third analyses might be desirable from the original sample, might some other kind of container that will keep out the air be tried, such as a syringe-type container?

*Dr. West:* We find that the best way is to use fully filled bottles, rubber stoppered, with no air in the top or a minimum—a small bubble of air. We do not use polyethylene bottles, for example, because polyethylene is not gas-tight or air-tight. As far as taking the sample from the machine is concerned, a syringe could be used.

*Mr. Misener:* I was thinking of the situation where you might take from the stoppered bottle a sample to analyze and maybe two hours or a day later you might wish to analyze again, and you've already introduced the air. Is there some container that would keep air out, regardless of how much solution you've had removed?

*Dr. West:* We don't yet have an answer to that. We've been trying the use of a polyethylene floating lid, inside a bottle, but that does not give an air-tight condition, though it improves keeping.

---

# Temperature Reduction in Motion-Picture and Television Studios Using Heat-Control Coatings

By F. E. CARLSON, G. T. HOWARD, A. F. TURNER and H. H. SCHROEDER

**High temperatures on sets increase production costs. The use of heat-control coatings in Fresnel lens spotlamps can reduce set heat due to lighting by at least 50%. Modifications of spotlamps to achieve this result are described. These make it possible to aim most of the infrared rays away from the set toward the roof or upper walls of a stage where heat is more easily removed. The diversion of infrared radiation in this manner reduces set temperatures and increases the comfort of actors and crew.**

THE SMPTE Committee on Motion-Picture Studio Lighting and Process Photography recently reported[1] that the motion-picture producing industry would welcome, among other things, light sources with less heat. The object of such developments is the reduction of heat on motion-picture sets—a reduction made necessary by the high light levels reported by the Committee and associated with present large-screen color photographic practices.

This paper presents the results of laboratory tests of a method for reducing set temperatures by modifying the spotlamps so widely used for set lighting. It is, therefore, a preliminary report to the extent that tests under actual set conditions remain to be made. Most of the heat generated on a set is due to the absorption of the nonactinic infrared radiation produced by the spotlamps. Suitable interference film coatings on the reflector and the lens of a spotlamp can optically separate invisible infrared radiation from visible light.[2,3,4] The visible is then directed toward the set and the invisible infrared away from the set.

Before proceeding to discuss in detail the methods involved, it seems desirable to consider briefly the association of heat with light. Figure 1 shows the radiation emitted by a tungsten filament lamp as a function of wavelength. It extends from 0.3 to 3.0$\mu$, the wavelength limits imposed by absorption in the glass envelope. Heat is generated when any of this radiation, including the visible, is absorbed by an object on which it falls. The visible radiation, which lies between 0.4 and 0.7$\mu$, is of course essential to photography; the remainder of the radiation could be eliminated with a resulting reduction in heat. This means that, in the ideal case, approximately 85% of the total beam energy could be diverted from the set without affecting the photographic effectiveness of the spotlamp. *Theoretically, then, 85% of the heating effect could be eliminated from the spotlamp beam.*

It is not the intent of this paper to discuss the details of interference film coatings, but a brief resume of their principles may also prove helpful. High vacuum evaporation processes readily permit the deposition of a succession of alternate films of two different nonabsorbing materials having widely different indices of refraction.[5] As the number of alternate films increases, the coating becomes more highly reflective, but only over a limited spectral range.[6] On either side of this high-reflectance region the reflectance is low, and, since all the films are nonabsorbing, the transmittance is high. *Any*

Presented on October 4, 1955, at the Society's Convention at Lake Placid, N. Y., by F. E. Carlson and G. T. Howard (who read the paper), Large Lamp Dept., General Electric Co., Nela Park, Cleveland 12; and by A. F. Turner and H. H. Schroeder, Scientific Bureau, Bausch & Lomb Optical Co., Rochester.
(This paper was received on January 10, 1956.)

**Table I. Effective Lens Transmittances by Spectral Regions.**

| | Visible | Infrared | |
|---|---|---|---|
| | 0.4–0.7μ | 0.7–1.5μ | 1.5–3.0μ |
| Uncoated glass | 92% | 92% | 70% |
| Transparent heat-reflecting coating on glass | 92% | 30% | 60% |

**Table II. Effective Mirror Reflectances by Spectral Regions.**

| | Visible | Infrared | |
|---|---|---|---|
| | 0.4–0.7μ | 0.7–1.5μ | 1.5–3.0μ |
| Aluminum mirror | 90% | 95% | 97% |
| Cold mirror coating on glass | 90% | 35% | 15% |

*Notes:* Computed Values — Normal Incidence; Tungsten Filament Lamp at 3350 K

*radiation not reflected by the coating is transmitted.* In the simple case, if all films are of equal optical thickness, the high-reflectance region centers about the wavelength for which each film is one quarterwave thick. Thus, the position in the spectrum of the region of high reflectance may be shifted by changing the thickness of all films. If this film thickness is chosen for high reflectance in the visible, the coating is transparent to the infrared. If thicker films are used the region of high reflectance shifts to the infrared and the coating becomes transparent in the visible. In practice, of course, many refinements are required in the design of these coatings, but their basic behavior remains that of this brief discussion.

Because of practical limitations on the number of films which can be used, as well as for other reasons, the coatings do not have the ideal optical behavior required to completely eliminate heat radiation. Thus their efficiency varies in different parts of the spectrum, as indicated in Tables I and II. For purposes of this discussion, it was found convenient to arbitrarily divide the infrared into two sections, one above and one below 1.5μ.

The heat-reflecting coating can be applied to the back of a Fresnel lens as indicated in Fig. 2. This results in a marked reduction of heat on the set. However, this arrangement increases the amount of radiation trapped in the spotlamp housing. This has two disadvantages. First, higher lamp temperatures result in poorer incandescent lamp performance. Second, the housing operates at a much higher temperature, with resulting increased discomfort to operators who must be near it.

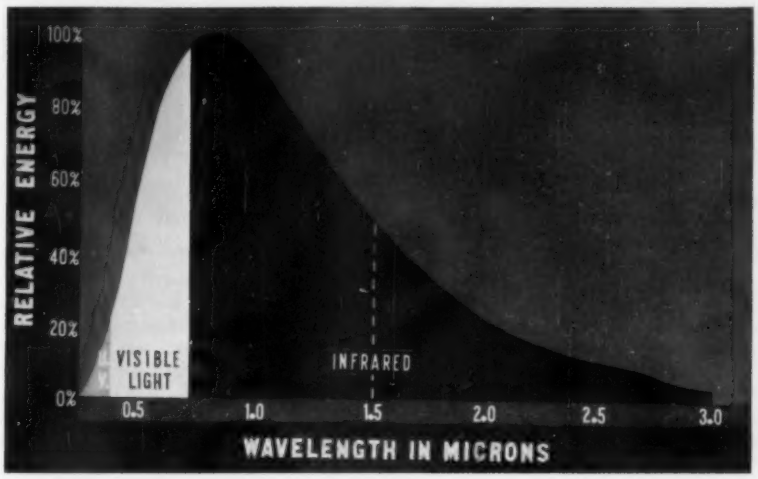


**Fig. 1. Relative spectral energy distribution from an incandescent lamp operating at 3350 K.**

Reduction of set temperatures need not increase lamp temperatures and impair incandescent lamp performance if the metal mirror is replaced by a "cold mirror," i.e., one that is transparent to infrared but reflective to visible. With such a cold mirror (Fig. 3) not only the infrared directly from the lamp but also the infrared reflected by the lens toward the mirror can pass directly through the mirror. Visible radiation on the other hand is reflected from the mirror in the usual way. The results of the substitution of the infrared-transmitting mirror are twofold: lamp bulb temperatures are reduced, resulting in performance superior to that obtained in existing equipment, and heat on the set is reduced even further. But, the spotlamp housing will be just as uncomfortably hot as before unless the back is removed as shown in Fig. 3.

Removal of the back of the housing allows some of the trapped infrared rays to escape and drops the housing temperature. The unobstructed passage of the infrared radiation through the open back is particularly important since radiation is not converted into heat until it is absorbed by the object it strikes. But despite this improvement there is still a

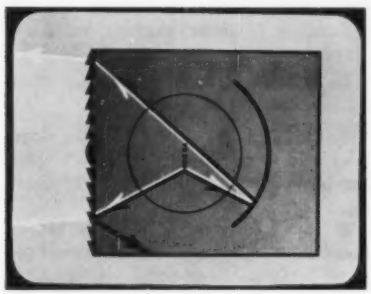

**Fig. 2. A heat-reflecting coating on the back of the lens reflects most of the infrared rays (black lines) back to the housing and the lamp bulb. The light rays (white lines) pass through the lens in the usual manner.**

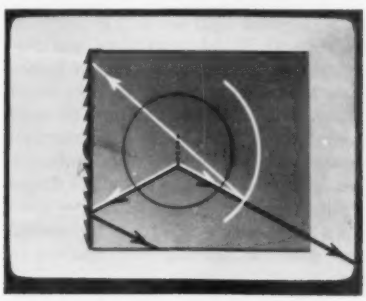

**Fig. 3. A "cold mirror" in combination with the arrangement shown in Fig. 2. Removal of the back of the housing is an essential step in directing infrared radiation away from the light beam.**

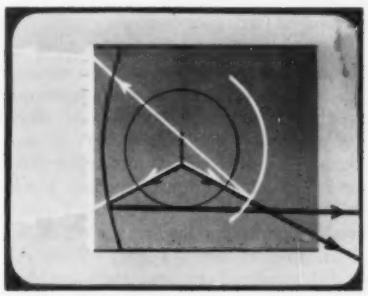

**Fig. 4. A heat-reflecting parabola, transparent to light, in place of the lens coating (Figs. 2 and 3) reduces spotlamp housing temperatures by "beaming" infrared (black lines) directly out the open back.**

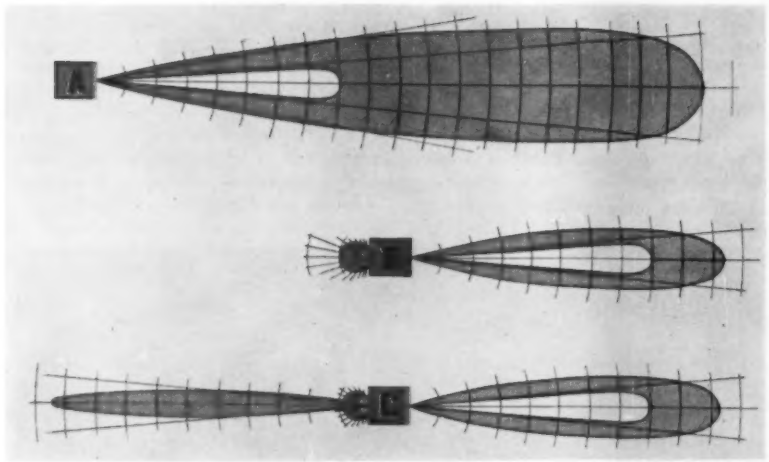


**Fig. 5. Spotlamp energy distributions with and without heat control coatings.**

Spotlamp A represents the typical unit with metal reflector and uncoated lens. Most of the radiation from this unit is in the forward beam which was about 27 mw of energy (shaded area) per lumen of light (white area) in the beam. Spotlamp B illustrates how the energy is split into two beams by a "cold mirror" and a heat-reflecting coating on the lens. The forward beam contains the same amount of light, but the total radiation in this beam is reduced to 13 mw/lm. About 100 mw for each lumen in the forward 8° spot-position beam are now directed out the open back of the unit. Spotlamp C indicates the increase in energy through the open back when a parabolic element with a heat reflecting coating is used instead of a coating on the lens. Light and total radiation in the forward beam remain the same but the energy in the rear beam increases to 200 mw/lm.

considerable amount of infrared reflected from the coated lens that strikes the inside of the housing.

D. W. Prideaux* provided the solution to this problem, by introducing a parabolic glass element between the lamp bulb and the lens. The heat reflecting coating is now applied to this element (Fig. 4) rather than to the lens. When properly focused the parabola beams the infrared radiation out the open back of the housing. Mounted on the lamp carriage this heat-reflecting element is equally effective for all focus settings. When such spotlamps are mounted above the set, the infrared is beamed directly to the roof or upper walls where heat removal is easy. Furthermore, the parabolic mirror avoids changing angles of incidence on the coatings as the focus is changed from spot to flood.

For convenience, the initial tests to determine the effectiveness of the various heat-reduction methods just described were made with a 750-w, 6-in. Fresnel lens spotlight. The results were so encouraging that more comprehensive tests were conducted and data are now available for both a 5000-w, 14-in. Fresnel lens "Senior" spotlamp and a 10,000-w, 20-in. Fresnel lens "Tener." Tests included candlepower and radiation distribution measurements for various focus settings of the spotlamp. These disclose that, for a given heat reduction method, the ratio of heat in the beam to illumination in the beam is independent of beam spread. The following data are therefore presented without reference to beam spread.

The beam of the typical spotlamp in use today contains about 27 milliwatts (mw) of energy for each lumen of light at 3350 K. Such spotlamps are equipped with a metal reflector and an uncoated lens. This relationship of total energy to light is shown by spotlamp A in Fig. 5. The substitution of an infrared transmitting reflector and the addition of an infrared reflecting coating to the lens drop the beam energy to 13 mw/lm. This 50% reduction in heat delivered to the set for equal illumination is illustrated by spotlamp B in Fig. 5. But note the broad distribution of radiation out the open back of the housing. This amounts to approximately 100 mw out the open back for each lumen in an 8° forward light beam. The addition of a parabolic element does not significantly change the 13 mw per lumen ratio for the light beam but does result in a definite beam of even more infrared from the back of the housing as illustrated by spotlamp C. The increased radiation in this invisible beam — to 200 mw/lm — results from the energy which, in spotlamp B, was reflected from the coated lens onto the housing and resulted in high housing temperatures.

Table III indicates how hot the spotlamp housing is for the designs just described. The use of the parabolic element results in a 12% reduction in heat absorbed and reradiated by the side of the spotlamp housing. Table III also illustrates the vital importance of the open back of the housing. In all cases the closed back results in hotter housings.

**Table III. Radiation at 1 ft From the Side of 5-kw 14-in. Fresnel Lens Spotlamp.**

| | Watts /Sq Ft |
|---|---|
| Clear lens and aluminum mirror | 57.6 |
| Coated lens and aluminum mirror | 64.0 |
| Coated lens and coated mirror | 63.2 |
| Coated lens and coated mirror with back of unit removed | 48.0 |
| Coated parabola and coated mirror with back of unit removed | 42.7 |

The values in Table III are a measure of the comfort or discomfort of the operator who must be near the spotlamps, and indirectly indicate the performance which may be expected from the lamp bulb within the housing. With heat control coatings in the combinations described for Figs. 5b and 5c, compared with the uncoated elements of Fig. 5a, the maximum lamp bulb temperature drops. A typical result is given in Table IV.

**Table IV. Maximum Bulb Wall Temperature 750-w, 3350 K Lamp in 6-in. Fresnel Spotlamp.**

| | |
|---|---|
| Clear lens and aluminum reflector | 580 C |
| Coated lens and aluminum reflector | 590 C |
| Coated lens and coated reflector | 505 C |
| Coated lens and coated reflector with back removed from housing | 480 C |

Such a reduction results in better lamp bulb performance because lowered glass bulb temperature usually means less bulb blackening and less bulb blistering. This means better lumen maintenance and better color temperature maintenance.

Color quality of light is of course of utmost importance for most studio lighting applications. In this connection it is important to understand that evaporated coatings provide wide flexibility. Hence, any color characteristic may be obtained. Preliminary color tests confirm the acceptability of these coatings for color photography.

In summary these laboratory tests have established the following:

1. On the basis of present technology a 50% reduction in set heat due to lighting is possible using heat-control coatings.

2. In all cases the back of the lamphouse must be opened for best overall results.

3. The use of an infrared reflecting parabolic element between the lamp and the lens makes it possible to aim infrared out the open back of the unit.

4. Housings designed to take full advantage of these coatings reduce the operator's discomfort due to heat.

* Large Lamp Dept., General Electric Co.

5. Such housing designs also improve lamp bulb performance.

6. For the color film emulsions in use the coatings are essentially neutral.

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### Discussion

*Anon:* Overlooking the possible difficulties of putting on these coatings, has putting the coating inside the bulb been considered, to send the heat back and save a little electricity by heating the filament?

*Mr. Howard:* Yes, it has. As you can imagine, this is much more difficult to accomplish than is the case with the elements described in this paper. In any event, the higher costs involved might make such a design uneconomical because the lamp bulb is the replaceable part.

*Gio Gagliardi (Stanley Warner Theatres):* Are those reflectors available for motion-picture arc projection lamps?

*Mr. Schroeder:* They will be shortly. We're working on that.

*Mr. Gagliardi:* What would their relative cost be as against the silvered-type reflector?

*Mr. Schroeder:* It is too soon to say but we predict that they will be available without too much of a penalty for this additional feature. The cost will not be prohibitive.

*Mr. Gagliardi:* Would this accomplish a greater reduction of heat on the film than the present heat-reflecting plates?

*Mr. Schroeder:* There will be some improvement over the present heat reflectors that we also make. You would probably notice instead of the present reduction of 30%, a reduction of 40 to 45%.

*Joseph Tanney (S.O.S. Cinema Supply Corp.):* Would there be any problem of the lamphousing overheating when the lamps are on a parallel at an acute angle?

*Mr. Howard:* Actually, the lamphousing itself operates much cooler when the heat passes through the reflector. Radiation measured at a distance of 1 foot from the side of a typical 5-kw lamphousing is about 63 w/sq ft. When the parabola is used and an infrared transmitting reflector is placed behind the lamp the unit is cooler and radiates only about 42 w/sq ft to the sides. Incidentally, the lamp bulb temperature also drops some 100 C.

*Mr. Tanney:* That's with the back of the lamp open?

*Mr. Howard:* Yes. With the back of the lamphousing closed it runs hotter.

*Mr. Tanney:* Will the operators need dark glasses if they're going to have this light thrown back?

*Mr. Howard:* That is very unlikely. The operator normally does not stand behind the unit, the mirror has a light transmission of only about 2%. (The 5-kw was turned around to demonstrate.)

*Anon:* Do you have a slide that gives the characteristics of these coatings?

*Mr. Schroeder:* Actually, as stated at the beginning of the paper, this is a preliminary report. We are planning a paper, possibly in the spring, which will give more detail on the spectral characteristics of both the heat reflecting coating on the Fresnel lens or parabolic element and also on the cold mirror, which is situated in back. The reflectance for the cold mirror is reasonably uniform at around 90 to 95% in the visible and falls off rather sharply in the infrared, transmitting most of the infrared from 0.7$\mu$ on out. Heat-reflecting filters have approximately uniform transmission of about 90% in the visible; transmission falls off sharply in the infrared. There are no sharp ups and down in the curves in either case.

*John Forrest (Ansco):* Are these coatings available on filters for printer use, etc?

*Mr. Schroeder:* Almost any color characteristic is possible with filters using evaporated film coatings.

*Frank P. Herrnfeld (Frank Herrnfeld Engineering Corp.):* Have any measurements been made of aging of this type of filter?

*Mr. Schroeder:* Not for these particular filters. Similar types for motion-picture projection work have been under tests now for about 500 hours without anything happening to the filters.

*Mr. Herrnfeld:* Does the spectral response of the filter change?

*Mr. Schroeder:* No, the heat involved in these applications doesn't change the spectral characteristics of the filters at all. That is one advantage over glass filters.

*Mr. Howard:* It should be emphasized that these do not contain a dye, nor do they contain any pigment, so there is nothing to fade.

*James G. Kemp, Jr. (National Carbon Co.):* Wouldn't the same advantages described for the incandescent light also hold true for the arc lamp?

*Mr. Howard:* Yes, for the light in the beam of the arc lamp. However, about 45% of the energy and, therefore, the heat in an arc lamp system is in the ballast. They could undoubtedly be effective in reducing the remaining 55% of the radiation.

# Optical Multiplexing in Television Film Equipment

By A. H. LIND
and B. F. MELCHIONNI

**The primary reason for multiplexing TV film cameras and TV film projectors is economy of equipment and/or space. A further reason can be the insurance of stand-by protection, at nominal cost, when continuity of programming assumes high importance. The optical multiplexer described here satisfies both requirements when integrated into a TV film pickup system. Design parameters and operation are discussed.**

Optical multiplexing in TV film pickup systems is the technique of arranging an array of film projectors and TV cameras in such a manner that a given TV camera can "look at" any one of several projectors when a "multiplexer" is introduced into the arrangement to provide optical path-switching. Optical multiplexing is in widespread use in TV broadcasting stations. The keynotes of its popularity are economy and efficiency.

There is economy of floor space when as many as three and sometimes four projectors can be used with a single TV camera. Such an arrangement provides for very efficient use of the TV camera since continuous programming is possible by switching from one projector to another as the program progresses. Efficiency and convenience of operation are also implemented in that remote control panels can be consolidated which, coupled with a lesser need for TV film camera chains, makes possible an operation with fewer operating personnel. There is economy and flexibility in replacing obsolete equipment. In a multiplexed installation the film projectors and TV cameras retain their autonomy and thus any one unit can be replaced with a newer one without changes being required on the remaining ones. In operations such as network program origination, a second copy of a film, usually 16mm, is run simultaneously as "protection" against failure in the primary program chain.

Multiplexing can increase the protection against equipment failure by providing cross protection, i.e., making it possible to use either film projector with either TV film camera. In color-film pickup the use of optical multiplexing can make programming more satisfactory because camera-to-camera switching can be avoided. Thus sometimes noticeable color shift between cameras can be eliminated. And, of course, an important consideration to the TV station owner is the economy of capital investment for equipment to do the film pickup job when multiplexing is used.

The design objective for an optical multiplexer is to achieve performance that does not disclose the presence of multiplexing in the final picture. To accomplish this satisfactorily, consideration must be given to the following requirements:

1. The optical focus and field flatness should not be disturbed by the multiplexer. This requires precise, planar reflecting surfaces.
2. The mechanical actions involved and the mounting rigidity must be controlled so as to not introduce picture motion due to vibration.
3. The multiplexer should be neutral in its spectral characteristics so as to not alter the color temperature of the projected picture or introduce color balance shifts between its channels.
4. The light transmission between any input and the output should be essentially the same. This provides the greatest freedom in equipment choice and arrangement. However, if designed for a particular array of equipment, the design might be such as to equalize the light from the several projectors and thus present an essentially constant light level at the TV camera.
5. The optical axes between all projectors and the cameras should be effectively coincident. This, of course, insures proper geometric positioning of all images as well as being a contribution to maintaining optimum optical focus, etc.
6. There should be negligible spurious image effects. That is, there should be no picture shading or residual displaced reflection images in evidence in the final picture.

### Basic Approaches to Optical Multiplexing

It was learned early in postwar TV broadcasting that several pictures could be projected simultaneously onto the mosaic area of the iconoscope film camera pickup tube. Two projectors could be placed in close proximity and their pictures imaged on the iconoscope mosaic with some compromise in the overall performance. The largest effect was the introduction of slight geometric distortion in the TV picture because the optical axis of the projector and that of the film camera would not be coincident. This "off axis" projection could introduce slight focussing

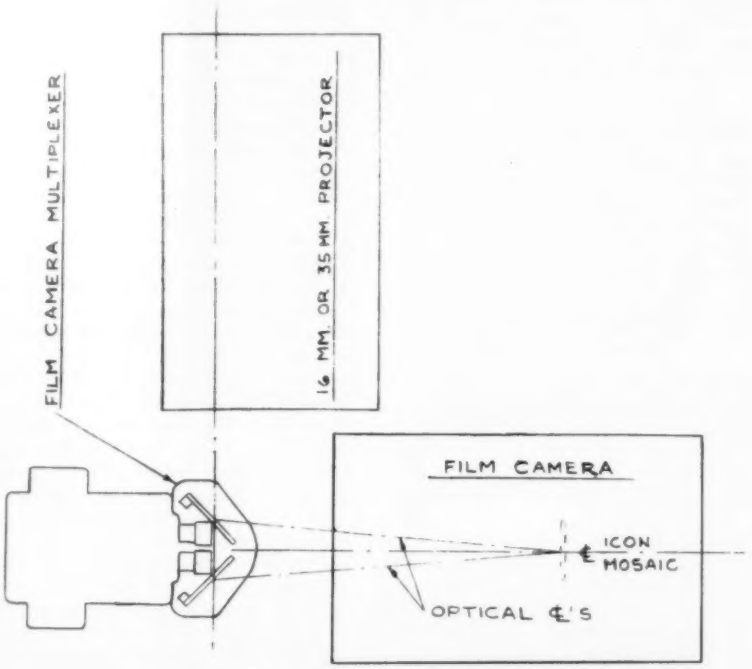



**Fig. 1. Iconoscope installation.**

Presented on October 7, 1955, at the Society's Convention at Lake Placid, N.Y., by A. H. Lind (who read the paper) and B. F. Melchionni, Broadcast Studio Engineering, Engineering Products Div., Radio Corp. of America, Camden 2, N.J.
(This paper was received on November 8, 1955.)

errors over the projected picture area, as well as introduce the "keystoning" geometric distortion. The net result in the reproduced TV picture, however, was considered quite acceptable.

To add convenience and further flexibility, the optical paths were folded by introducing mirror reflectors as is shown in Fig. 1. In this arrangement two motion-picture projectors and a slide projector can readily be multiplexed into an iconoscope TV camera. An ever present problem in projection of a picture is jump or weave of the viewed picture. In addition to other contributing factors, relative motion of the projector and TV camera can aggravate the observed effect. However, extended field experience proved that the amount of motion introduced by mechanical vibration could be held down to a negligible amount when an area the size of the iconoscope mosaic ($3\frac{9}{16} \times 4\frac{3}{4}$ in.) is used for the projected image. Further, any tendency to reduce resolution because of picture smear caused by motion during the open shutter period is greatly reduced by the short (6%) exposure period that is used.

In recent years the newer vidicon TV pickup tube has come into widespread use for TV film cameras. It is physically much smaller than the iconoscope. The vidicon camera is thus smaller. Also, the image area on the vidicon is greatly reduced compared with that on the iconoscope. The $\frac{3}{8} \times \frac{1}{2}$ in. image dimensions on the vidicon are more than nine times smaller than the $3\frac{9}{16} \times 4\frac{3}{4}$ in. on the iconoscope. This difference magnifies the effect of vibration of the vidicon by this factor of nine. Since the vidicon camera is small it has proven satisfactory to mount it rigidly to the projector where only one projector is involved. Large aperture, short focal length and fast optics are used which makes the throw distance small for the near unity magnification ratios required.

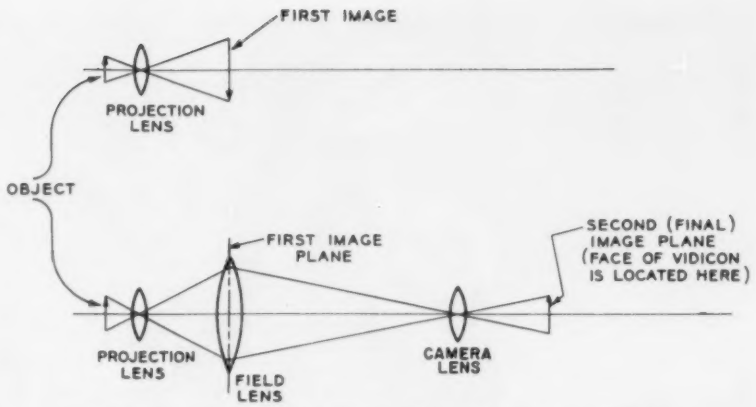


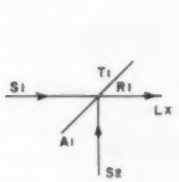

**Fig. 2 Above: simple projection system. Below: field lens projection system.**

The short optical throw plus the potential difficulty with vibration makes the prospect of successfully multiplexing several projectors into one vidicon camera by direct projection quite unlikely. To overcome these limitations, the use of an intermediate image system was explored. An enlarged image was formed at a given focal plane by means of the projection lens system. A second objective lens was then placed at the camera end of the system to image the enlarged projected picture onto the vidicon photo layer. Initial attempts included the trial of both a translucent screen and a highly reflecting screen for the intermediate image. In both cases screen granularity proved to be too limiting to make these approaches practical. In addition, the light loss with a reflecting screen was greater than could be tolerated.

A different scheme which was successful is shown in Fig. 2. In this system the intermediate image is formed in the "field" lens. The projected picture is focussed at the plane containing the optical center of the field lens. The camera lens is then focussed to image this plane on the vidicon. The image at the field lens should be as large as space requirements and lens selection allow. The smallest satisfactory and practical image has been found to be one having a $3\frac{1}{8}$-in. diagonal. The image size employed in the RCA 3-V color system is $5\frac{9}{16}$-in. diagonal. The field lens system, while solving the difficult problems, is not without compromise. A field lens system does not permit "off axis" projection because of loss in efficiency and introduction of serious "shading" types of field illumination deficiencies when used this way. Therefore an entirely new series of multiplexers was developed to exploit the field lens multiplexing system.

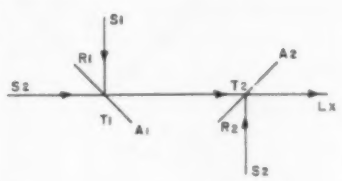
### "Coaxial" Optical Multiplexing

The simplest means of providing optical mixing while keeping the optical axes effectively coincident is a semi-mirror. It can be used to provide one optical path by reflection and a second by transmission. One mirror can establish two paths, two mirrors three paths, etc. However, such a system can introduce appreciable light loss due to the semitransmitting, reflecting nature of the mirrors plus some loss due to absorption.



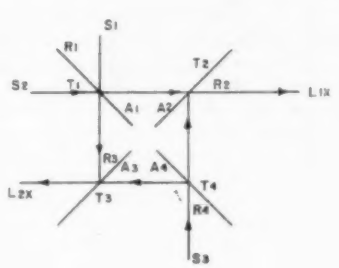

for $E_1 = E_2 = E$

$E = {}^1/_2(1 - A_1)$




for $E_1 = E_2 = E_2 = E$

$$E = \frac{(1 - A_1)(1 - A_2)}{3 - A_1}$$




for $E_{11} = E_{12} = E_{13} = E_{21} = E_{22} = E_{23} = E$

$E = {}^1/_4(1 - A_1)(1 - A_3)$

**Fig. 3. Semi-mirror optical mixing systems.**

$S_X$ = Source X illumination
$T_M$ = Transmission factor of mirror M
$R_M$ = Reflectivity factor of mirror M
$A_M$ = Absorption factor of mirror M
$L_X$ = Light output from source X
$E_X = \frac{L_X}{S_X}$ = optical efficiency of path X

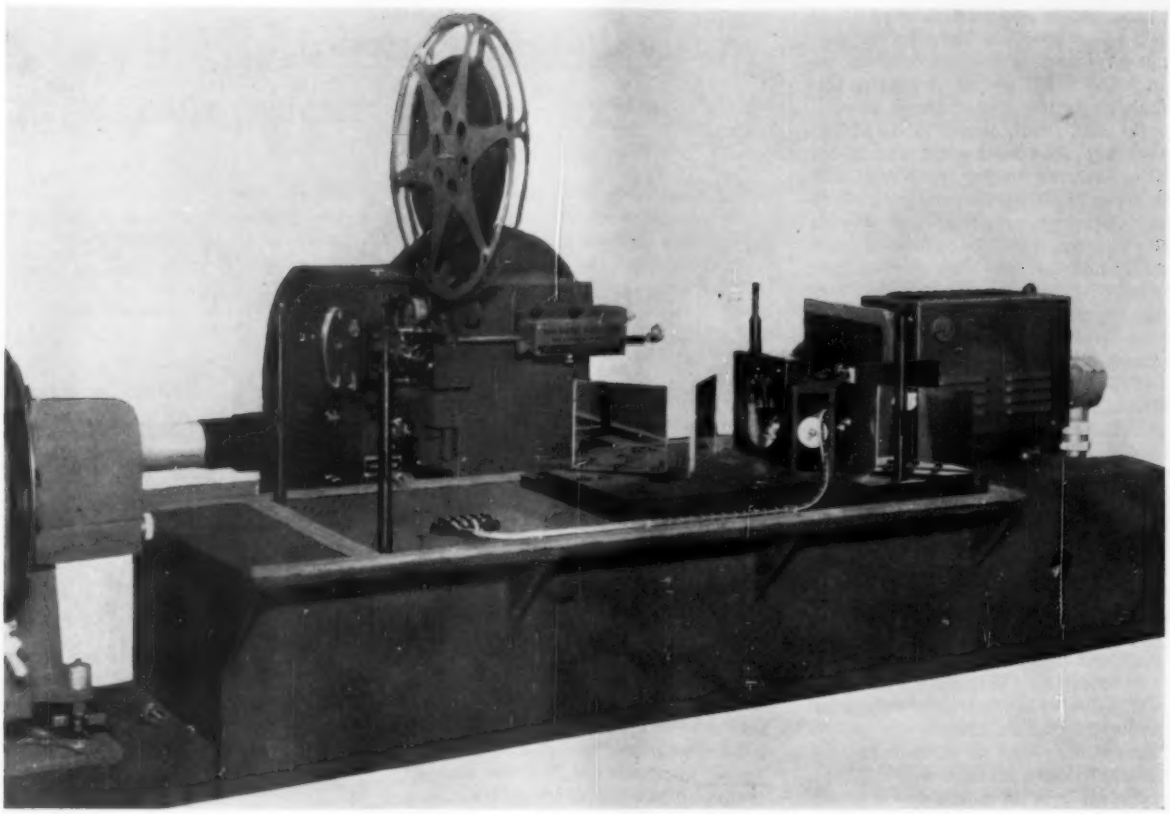


Fig. 4. RCA TP-11 Multiplexer, a semi-mirror multiplexer.

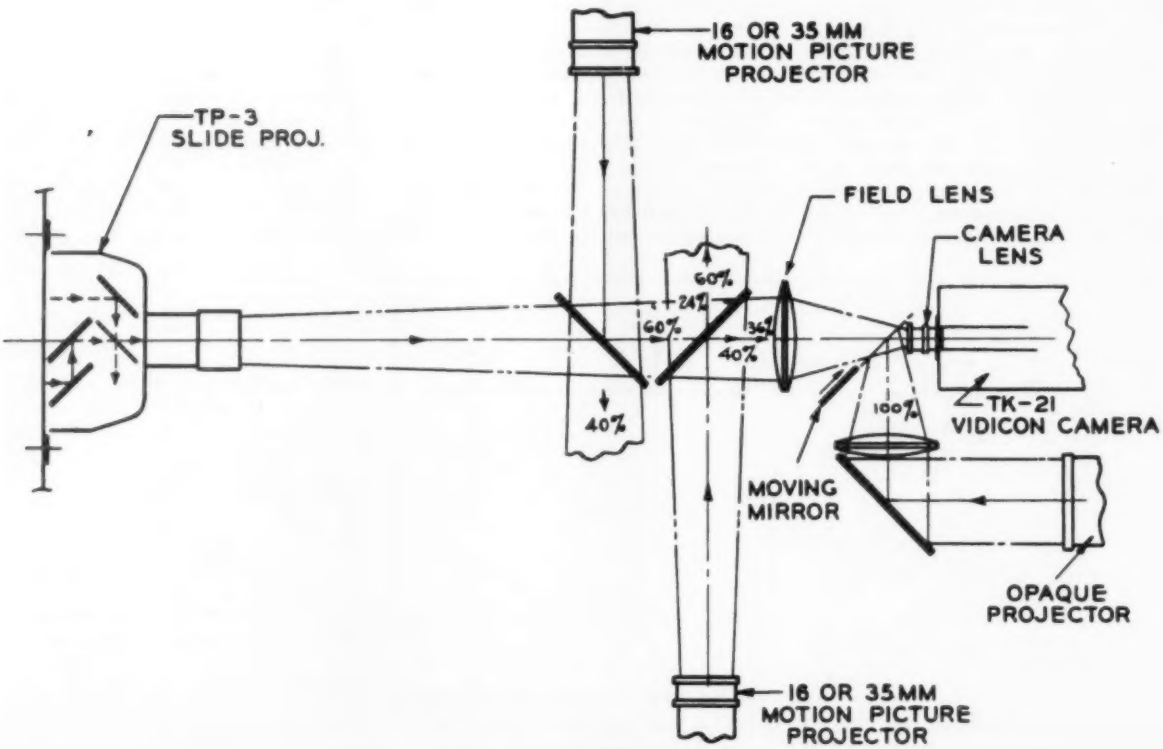



Fig. 5. RCA TP-11 Optical System.

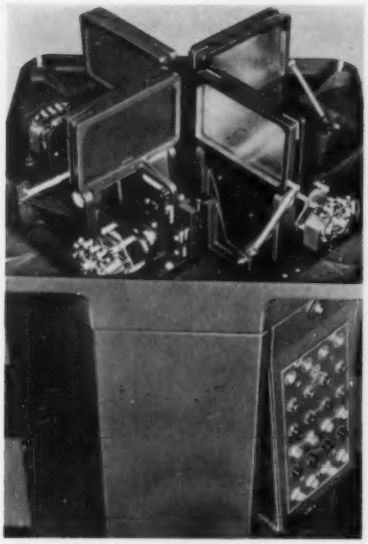


**Fig. 6. Moving mirror mechanism on RCA TP-15 Multiplexer.**

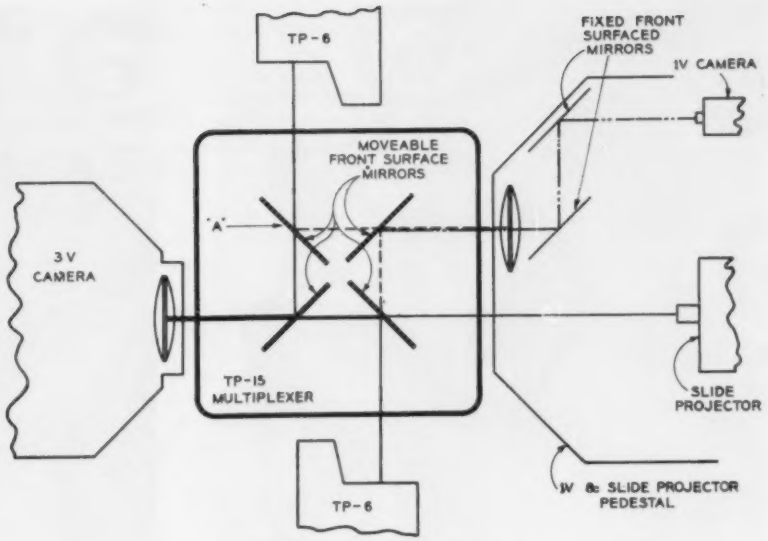



**Fig. 7. RCA TP-15 Optical System.**

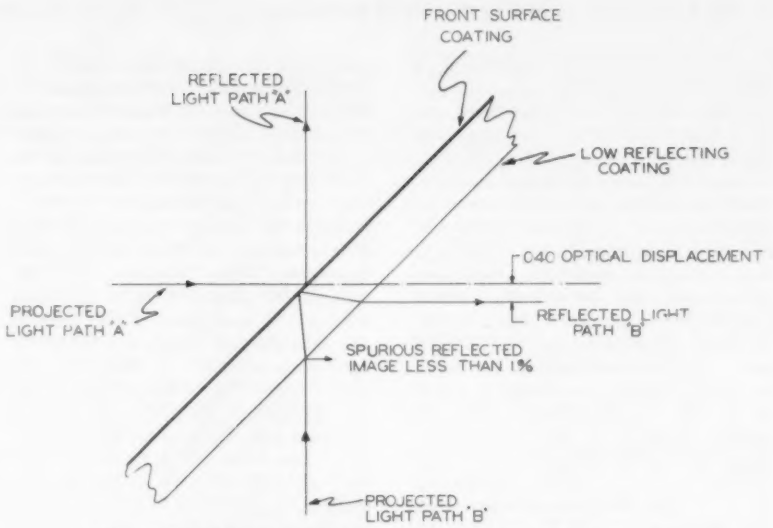



**Fig. 8. Special front-surfaced mirror used in TP-15 Multiplexer.**

Figure 3 illustrates three semi-mirror mixing systems that can accommodate two inputs and one output, three inputs and one output and three inputs with two outputs respectively. The maximum efficiencies, discounting absorption losses, are inversely proportional to the number of inputs when parameters are chosen to keep all channels equal in efficiency. This lack of optical efficiency can become a limiting factor in some systems.

Semi-mirror surfaces are normally deposited on planar glass plates of sufficient thickness to provide adequate mechanical strength and rigidity. The second surface of the glass plate can give rise to extraneous reflections that result in displaced "ghost" images in the resulting TV picture. Low reflection coatings must be applied to these surfaces to suppress such reflections to an acceptable level.

A third consideration important to the use of semi-mirrors for mixing is the difficulty encountered in maintaining color balance between the transmitted and reflected channels. Any tendency for the mirror to depart from a neutral spectral response tends to be amplified as a difference when the transmission and reflection characteristics are compared. This is, of course, a minor problem in monochrome TV.

The RCA TP-11 Multiplexer, designed for monochrome service, shown in Fig. 4, is an example of a commercial product designed to employ semi-mirror mixing. This multiplexer is solidly constructed to support an accurately machined optical bed plate for mounting the semi-mirrors. Figure 5 is a diagram of the optical paths and the mixing mirrors. The reflection-transmission ratios for the mirrors were chosen to keep the efficiencies for the two motion-picture projector paths equal and as high as is consistent with a reasonable compromise on the efficiency of the slide projector path.

A second way of achieving optical path selection is that of providing a movable full-reflecting mirror positioned to interrupt one path and introduce another when it is moved into the operating position. This approach is more complicated than the semi-mirror one because a mechanism is required to move the mirror. It also has the disadvantage that only one optical path at a time can be used. However, for color TV systems it offers two important advantages. The optical efficiency is high because full-reflecting mirrors are used. Also, the problem of channel-to-channel color balance is essentially nonexistent.

The problem of moving a mirror into or out of its operating position so as to result in a quick, smooth and pleasing transition from one picture source to another is a difficult one. Various ways of moving the mirror in the plane of its operating position were tried. In one system the mirrors were moved vertically by means of a rack and motor-driven pinion gear. The large motor required to make the mirror motion sufficiently fast was inconsistent with the need for smooth, rapid braking at the limits of mirror travel. A modified system in which a continuously running motor was engaged or disengaged by means of electrically operated clutches also proved unsatisfactory.

The system adopted for RCA equipment designs is one in which the mirror is pivoted about its lower edge. As can be seen in Fig. 6 the mirror is moved 90°

Fig. 9. Installation employing RCA TP-15 Multiplexer.

Fig. 10. RCA TP-15 Multiplexer and auxiliary equipment.

by a captive crank which is driven by a reversible high starting torque motor. The advantages of this type of drive are many but probably the most important one is that of being self braking. Because of the simple harmonic motion nature of the drive, the force vs. velocity curves are complementary. At the start of the motion maximum power is transmitted and the velocity is minimum. Half way through the cycle the velocity is maximum and the transmitted power is minimum. At the end of the cycle the braking power is a maximum and the velocity a minimum. The unit comes to a stop so gently that no provisions are made to absorb an impact shock. A nylon stop pad is used which serves as an indexing pin as well as an adjustable stop to accurately position the mirror in a vertical position.

The complete transition cycle takes 1/5 of a second. In operation approximately 10° movement of the mirror wipes the picture from the field lens. This requires about 1/20 sec. Thus when a mirror is being moved out of operating position the picture goes to a black screen in 1/20 sec and the second channel is faded in as the moving mirror uncovers that path. The overall effect is quite acceptable visually. The dousing action of the moving mirrors is so satisfactory that some broadcasters have dispensed with dousers on the projectors.

### The RCA TP-15 Multiplexer

The latest in the series of Coaxial or "On Axis" Multiplexers designed for vidicon use, the RCA TP-15 Multiplexer is designed around a moving mirror array.

The optical arrangement of the TP-15 is shown in Fig. 7. This system makes it possible for the operator to multiplex any of three and in some cases four inputs into either of two outputs. When feeding one output from a given projector the other output can be connected to any of the remaining inputs. Thus a valuable preview function can be realized.

While the mirrors used are all front surface full silvered, there are two paths used which require that the light pass through the glass base before and after reflection. The diagram of Fig. 7 shows this to be the case when a slide projector light path requires reflection from two mirror surfaces in the multiplexer optics. The addition of glass in these paths as well as a glass surface require some special considerations (Fig. 8). First, spurious reflections from the unsilvered glass surface are suppressed to less than 1% of the incident light by the use of a low-reflection coating such as RCA "Magicote C." Second, by keeping the base glass thin the reflected image displacement due to refraction is less than 0.040 in. Thus 0.040 displacement is divided with the other channel so that a total deviation of 0.020 in. appears as an axis shift at the field lens. Third, the path length is effectively lengthened by the introduction of glass. This change, since it is approximately $\frac{1}{3}$ of 1% of the total path length, can be adequately accommodated within the depth of field of the optical system.

TV film systems built around the TP-15 multiplexer are versatile. Here are a few of the possible combinations:

1. 3-V Camera, 1-V Camera, 2 motion-picture projectors and 1 2×2 slide projector as shown in Fig. 9.
2. 2 3-V Cameras and 2 motion-picture projectors.
3. 2 1-V Cameras, 2 motion-picture projectors, 1 slide projector and 1 slide projector or Telop.
4. 1-V Camera, 3 motion-picture projectors.

It should be noted that the first combination provides for the integration* of color and monochrome systems while using the same motion-picture and slide projectors. This most important feature allows the broadcaster that is just starting or one that is enlarging his facilities in monochrome to do so with this equipment and not find it obsolete when he shifts to color.

To increase the flexibility and enable the user to make up his own combinations this equipment has been designed as a series of building block units.

The main pedestal, which is the heart of the system, contains all the control circuitry and relays required to operate the system. It has been designed to support a stable platform for the moving mirror mechanisms mounted atop it. The four moving mirror mechanisms are identical and similar to those previously described.

The 1-V Camera and slide projector shelf provides a stable platform for the slide projector to be used in the system as well as supporting the 1-V optical assembly and its TK-21 Camera. This unit is equipped with panel mounting angles and doors and can accommodate 36 in. of rack-mounted equipment at a very convenient place.

The 1-V Optical Assembly consists of a field lens and a pair of front surfaced

* A. H. Lind, "Some notes on integration of color equipment and existing monochrome facilities," *Broadcast News*, vol. 84, Aug. 1955, p. 30.

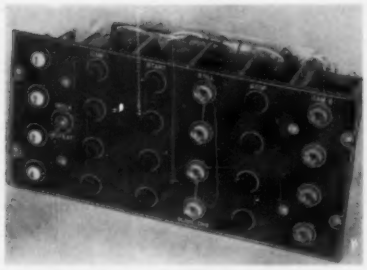


**Fig. 11. Control panel for RCA TP-15 Multiplexer.**

mirrors to fold the optical path for a more compact arrangement while offsetting the 1-V Camera to provide space to mount a 2 × 2 slide projector. The camera and camera lens are mounted to the same optical bed plate that supports the field lens. The camera is mounted on a focussing mount. A vernier adjustment is provided for ease in setting up and checking focus when desired. Figure 10 shows the pedestal and 1-V optics in operating position when used as part of the TP-15 Multiplexer.

The electrical control circuits are designed to perform several functions. The selection and actuation of motors that drive the mirrors are, of course, basic to the multiplexer. In addition there is the need to switch the sound channel from one motion picture to another at the time of switching pictures. Further, tally light circuits for indicating the status of the multiplexer mirrors are a necessity. Also, since it is becoming commonplace to include a means of controlling the light output from projectors, such as the light intensity control described previously,* switching to select the proper light-intensity control simultaneous with switching to a given projector is provided.

For operational convenience all projector and multiplexer switching can be accomplished from the multiplexer control panels, either the local or the remote one. Figure 11 shows the control panel pushbuttons labeled Start, Still, Stop, Camera 1 and Camera 2 and available for each of the two motion-picture projector inputs, while the two slide projector inputs employ the still button position for a slide change button.

The circuits are electrically interlocked to provide "hold" contacts which make momentary depression of the pushbuttons all that is required to actuate and sustain the mechanical change cycles. In addition, interlocking is provided so that the pushbutton switches associated with one of the cameras (it can be either one) have priority over the other set. Thus, if set up to give Camera 1 switches priority, pushing Camera 2 switches will not take the projector away from Camera 1 but still permits Camera 2 to look at any of the other projectors. This facility avoids the possibility of an "On Air" signal accidentally being switched off.

Tally light circuits are controlled by microswitches that are actuated in the limit positions of the moving mirror holders. Therefore, when a tally light is energized the operator has assurance that the mirror is in the proper position and not merely that a relay has been energized which might have failed to start the mirror drive motor.

To facilitate installation, maintenance and servicing, the relays and associated electrical components are assembled on a panel in the base of the main pedestal that is mounted on rollers so that it can be pulled out for access. Figure 12 shows the panel in its withdrawn position.

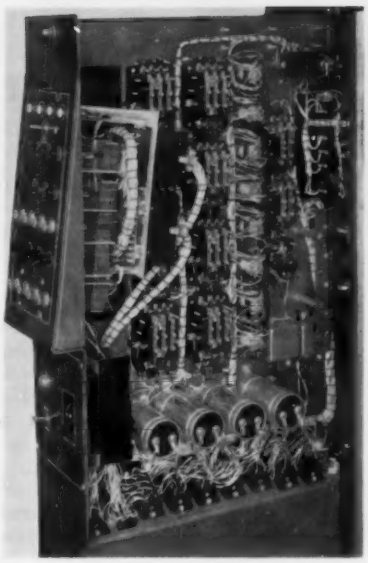


**Fig. 12. Control circuits for RCA TP-15 Multiplexer.**

## Conclusion

Efficiency and economy in TV broadcasting have been appreciably augmented by the use of optical multiplexing in film pickup systems. The performance of multiplexers has been developed to the point where their widespread acceptance and use are a matter of fact. Optical multiplexing is likely to become an increasingly important characteristic of future TV broadcasting equipment.

## Discussion

*C. J. Staud (Eastman Kodak Co.)*: I wonder if any special precautions were required to prevent dust on the mirrors in this complicated setup involving motors and switches and moving parts that might interfere with maintenance and good operation.

*Mr. Lind:* I assume you're speaking of the second unit for which there is a cover, but it is not dust tight. In the first case where the semi-mirrors were used there is a dust-tight cover. Rather than attempt to seal it we've made the cover readily removable so you have access to dust off the mirrors if there is a problem of dust. Most stations have their studios air-conditioned and the amount of dust is minimized although not completely eliminated. It hasn't been a particular problem.

*Phillip B. Laeser* (WTMJ-TV): From a practical standpoint, have you run into any explanation for a reflection that is experienced by quite a number of TV stations using the first optical multiplexer particularly. Is it due to the dust on it or an aging of the lenses? It seems that as we put in new sets of mirrors this was eliminated but, as several months passed, this reflection similar to a displaced image returned. Could you explain that?

*Mr. Lind:* Yes, this is the ghost image I mentioned, which is one of the problems in making a satisfactory unit. You must suppress these to the point where they are not evident in the picture. It is essential that the mirror surfaces be kept clean and that was the reason for making a dust tight cover. At both ends of the possible conditions you may have difficulty. If the mirrors are dirty, coated with dust and oil, the effectiveness of the film for suppressing the reflections is minimized and the images can build up. Usually they are somewhat diffused in this case although not appreciably. At the other limit, you mentioned replacing mirrors. There have been instances of this being necessary, usually because people are too fastidious. They do too much cleaning. It is possible, if you do very extensive cleaning of these mirrors, to wipe the coating right off the surface. We've found from some mirrors that have been replaced that this is what happens. People are so careful and do such a good job of cleaning that they take the coating right off. It then becomes ineffective.

*Mr. Laeser:* In the second set of mirrors we had warned the operating and maintenance group to more or less keep their hands off and in about four months the phenomenon appeared again and I wonder now what is your recommended procedure for cleaning the mirrors?

*Mr. Lind:* The mirrors are normally cleaned in our engineering lab and in the plant by using a neutral detergent. I don't remember at the moment which of the detergents has been found most satisfactory. Most of them are inclined to be a little acid or alkaline, I'm not sure that they are consistent in that respect. But we have learned from Proctor and Gamble that one of their detergents is neutral and by using this and merely wiping it on and off without using excessive rubbing we've been successful in cleaning them and keeping them in good shape for a long time.

*Dr. Staud:* May I comment briefly on that? The chemistry of the situation is very clear. There are a large group of non-ionic detergents, the type to which you are referring, and I am sure that they can be easily obtained.

* K. Sadashige and B. F. Melchionni, "Control of light intensity in television projectors," *SMPTE Jour., 64:* 416–419, Aug. 1955.

# Anamorphic Mirror Systems

By A. BOUWERS
and B. S. BLAISSE

**New afocal anamorphic systems with cylindrical mirrors are described. Image quality and distortion are discussed. Means of compensating the upward horizon distortion resulting from downward projection on a curved screen are given.**

THE USE OF anamorphic systems in optics is very old. As far back as the first half of the last century Brewster[1] developed a set of prisms with anamorphic action. With two of such sets turned at an angle of 90° he made an enlarging telescope of small power.

A Zeiss patent of Rudolph of 1899[2] describes anamorphic systems composed of cylindrical lenses with crossed generatrices, whereas Burch[3] in 1904 gives an afocal combination of cylindrical lenses with parallel generatrices. The latter system is on the analogy of an astronomical telescope if the "eye piece" is positive, and of a Galilean telescope if it is negative.

Chrétien[4] in 1930 applied anamorphic systems to cinematography. He improved the lens system of Burch which he placed in front of the objective of a camera, thus producing a "squeezed" image which was drawn out to normal proportions by applying a similar lens system between the projection lens and the screen.

This paper deals with a third group of anamorphic systems in which cylindrical mirrors are employed.[5] The use of mirrors has two great advantages, the most obvious of which is the absence of chromatic aberrations. Moreover, the spherical aberration of a cylindrical mirror is very small as compared with that of a cylindrical lens with the same aperture and the same focal length. It proved possible to obtain very good image definition with a system composed of two mirrors only. These systems are designed, patented and manufactured by the Old Delft at Delft, Holland, and are called Delrama Systems.

### The First Delrama System

The most obvious method of making an anamorphic system of zero power by means of two cylindrical mirrors is indicated in Fig. 1, showing a section perpendicular to the generatrices of the cylinders. $M_1$ is a concave, and $M_2$ a convex mirror of which the focal points F coincide on the optical axis FA. The anamorphic factor $\beta$ is, as in the case of the Chrétien lens, the ratio of the focal lengths of the two components.

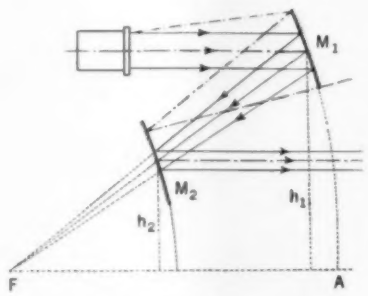



**Fig. 1. Delrama I—the most obvious method of making an anamorphic system of zero power by means of two cylindrical mirrors.**

The mirror $M_1$ produces under- and $M_2$ overcorrection, the aberration of the former being predominant.

The "excentric" distance $h_1 - h_2$ must be so great that there will be no vignetting in the field (see dash-dotted lines).

In consequence of this great distance the amount of aberration is fairly large, but can be reduced by shifting the two mirrors with respect to each other in such a way that two points of the caustical curves of $M_1$ and $M_2$ coincide.

Reasonably satisfactory definition may be obtained in this way for limited fields and anamorphic ratio; but a perfect definition can be achieved by adding a cylindrical lens, one surface of which is either the concave or the convex mirror. Such a solution is indicated in Fig. 2.

The focusing at finite distances is achieved by shifting one of the mirrors along the optical "axis."

### The Second Delrama System

An apparently much less obvious solution with reduced aberrations is indicated in Fig. 3. Here two sections are drawn, I being parallel to, and II perpendicular to the generatrices of the two cylindrical mirrors $M_1$ and $M_2$. In the last section it can be seen that the incident height h of the border ray is reduced by a factor of about 6 as compared with Fig. 1. As the spherical aberration is proportional to the third power of h, the reduction is by a factor of about 200. The resulting aberrations for beams parallel to the optical axis and forming angles of 3° 54′ and 7° 45′, corresponding to the half field and whole field of an unconventional film (CinemaScope), in combination with a projection lens of 85mm focal length are shown in Fig. 4. The radii of curvature are 538 mm for the concave and 269 mm for the convex mirror, giving an anamorphic ratio of $\beta = 2$.

For beams not perpendicular to the generatrices of the cylinders the aberrations remain the same. This is a consequence of a property of mirror reflection, as the geometrical projection of the incident and the reflected rays on the plane II (Fig. 3) is independent of the angle between the rays and this plane.*

* Here and often in the following paragraphs the word "projection" is used in a geometrical sense, and is to be distinguished from the light projection of the image on a screen.

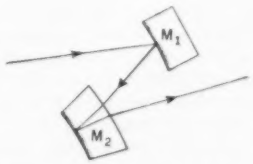



**Fig. 2. Delrama I'. Adding a cylindrical lens, one surface of which is either the concave or convex mirror, aids in more perfect definition.**

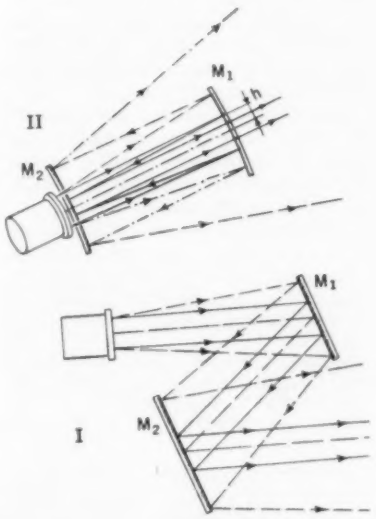



**Fig. 3. Delrama II. A solution of problem which provides for reduced aberrations.**

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(This paper was received by *Optica Acta* on October 13, 1954.)

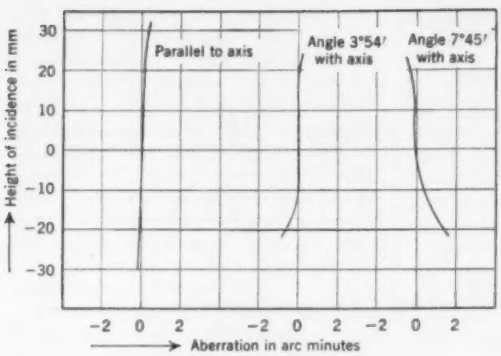


Fig. 4. Aberration of the Delrama II.

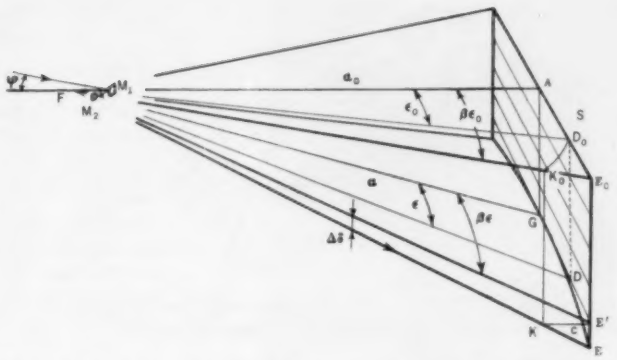


Fig. 5. Distortion produced by the anamorphic system of Delrama II.

**Distortion**

The anamorphic system of Fig. 3 produces a distortion of the image which is in many cases advantageous to compensate the distortion resulting from downward projection on a curved screen in cinema theaters. We will revert to this question later on.

This section is intended to discuss the degree of distortion and how it depends on the factors involved.

Our starting point is the fact already mentioned in the preceding section that geometrical projection of light rays on a plane perpendicular to the generatrices is independent of the angle between these rays and the plane of projection.

In Fig. 5 the two mirrors $M_1$ and $M_2$ have the common focus F. The screen S is considered to be at a large distance $a_0$ from F, parallel to the vertical generatrices of $M_1$ and $M_2$.

The principal ray $FD_0$ of a substantially horizontal beam would intersect the screen S at a point $D_0$ if the mirrors $M_1$ and $M_2$ were absent. Because of the presence of the anamorphic system this ray is diverted to $FE_0$ intersecting the screen S at $E_0$ in such a way that $AE_0 = \beta AD_0$, where $\beta$ is the anamorphic magnifying ratio.

Now we will consider another incident ray FD having the same projection $FD_0$ on the horizontal plane $FAD_0$ and making an angle $\varphi'$ with this plane. Its point of intersection with the screen is E, and

$$p_0 = E_0E - AG = (FE_0 - FD_0)\operatorname{tg}\varphi'. \quad (1)$$

As now in Fig. 5

$$FD_0 = a_0/\cos\epsilon_0 \text{ and } FE_0 = a_0/\cos\beta\epsilon_0$$

we find

$$p_0 = a_0\operatorname{tg}\varphi'\left(\frac{1}{\cos\beta\epsilon_0} - \frac{1}{\cos\epsilon_0}\right) \approx \frac{a_0}{2}\epsilon_0^2(\beta^2 - 1)\operatorname{tg}\varphi'. \quad (2)$$

Here $\epsilon_0$ is the projection on the plane $FAD_0$ of the field angle $\epsilon$. Now if the incident ray lies in a plane forming an angle $\varphi$ with the plane $FAD_0$, then

$$\operatorname{tg}\varphi' = \operatorname{tg}\varphi\cos\epsilon_0 \approx \operatorname{tg}\varphi$$

for small values of $\epsilon_0$.

All incident principal rays lying in this plane will intersect the screen in a straight line GD, the deviated rays, however, in a curved line GE, which is to a first approximation a circle with radius $r_0$.

The reciprocal of $r_0$ is given by

$$\frac{1}{r_0} = \frac{2p_0}{(GE')^2}, \text{ and as } GE' = a_0\operatorname{tg}\beta\epsilon_0 \approx a_0\beta\epsilon_0$$

we find

$$\frac{a_0}{r_0} = \left(1 - \frac{1}{\beta^2}\right)\operatorname{tg}\varphi. \quad (3)$$

The distortion described by relation (3) may also be understood as a consequence of image curvature. In reality we are concerned with a beam of incident rays converging to the screen at the point D situated a distance $a_0\operatorname{tg}\varphi$ below the point $D_0$ of Fig. 5. In a plane parallel to the generatrices of the cylinders $M_1$ and $M_2$ the convergence of the rays is not influenced. Thus the deviated rays will converge to K after having covered in a horizontal direction the distance $FK_0 = FD_0$. For small values of the angle $\epsilon$ the points K and $K_0$ are situated in front of the screen at a distance c

$$c = a_0\left(\frac{1}{\cos\beta\epsilon_0} - \frac{1}{\cos\epsilon_0}\right) = \frac{a_0}{2}\left(1 - \frac{1}{\beta^2}\right) \quad (4)$$

corresponding to a "radius of curvature" $r_{00}$ of the image given by

$$\frac{a_0}{r_{00}} = 1 - \frac{1}{\beta^2}. \quad (5)$$

Formula (3) gives the distortion radius $r_0$ if the screen S is parallel to the generatrices of the anamorphic system. In general, however, this is not the case. If the screen is perpendicular to the central principal ray FG (and thus forms an angle $\varphi$ with the generatrices of $M_1$ and $M_2$) the distortion curvature must be multiplied by a factor $\cos\varphi$, and if the screen is now tilted through an angle $\gamma$ it must again be divided by $\cos\gamma$ (Fig. 8). If the distance FG is indicated by a, then, because of $a = a_0/\cos\varphi$, we obtain instead of the relation (3) the new formula for the radius r on the tilted screen

$$\frac{a}{r} = \left(1 - \frac{1}{\beta^2}\right)\frac{\operatorname{tg}\varphi}{\cos\gamma}. \quad (6)$$

In cinema projection the distortion will be different for horizontal lines at different heights. If half the projection angle in a vertical direction is denoted by $\psi$, we find by applying Eq. (2) and (6) for the relative curvature $a/r_t$ of the top horizontal lines and $a/r_b$ of the bottom horizontal lines

$$\frac{a}{r_t} = \left(1 - \frac{1}{\beta^2}\right)\frac{\operatorname{tg}(\varphi - \psi)}{\cos\gamma}$$
$$\frac{a}{r_b} = \left(1 - \frac{1}{\beta^2}\right)\frac{\operatorname{tg}(\varphi + \psi)}{\cos\gamma} \quad (7)$$

**All-Glass Delrama System**

Instead of taking two cylindrical mirrors $M_1$ and $M_2$ one may employ a solid glass body in the shape of a rhombohedron of which the two oblique surfaces $M_1$ and $M_2$ are shaped cylindrically with the generatrices parallel to the plane of the drawing (Fig. 6).

Here again the anamorphic ratio $\beta$ equals the ratio of the radii of the curvature.

Focusing at finite distances is achieved by dividing the rhombohedron by a nearly horizontal plane into two prisms and by shifting one of the prisms along the dividing surface, thus diminishing the distance between the reflecting surfaces $M_1$ and $M_2$.

This all-glass system has several properties differing from that of Fig. 3, all of which have the same cause, viz., the refraction of skew rays on the plane entrance and exit surfaces of the rhombohedron.

As beams corresponding to the border of the image form in the glass a much smaller angle with the central ray than in air, the dimensions may be reduced. Furthermore, the distortion is different.

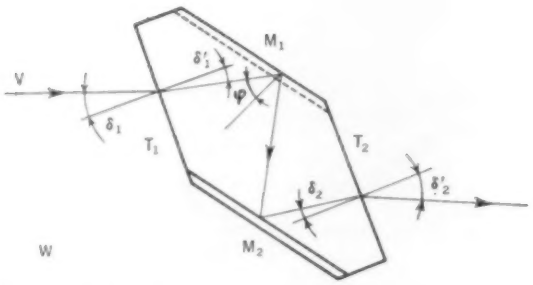


**Fig. 6. All-glass Delrama II employs a solid glass body, of rhombohedron shape, instead of two cylindrical mirrors.**

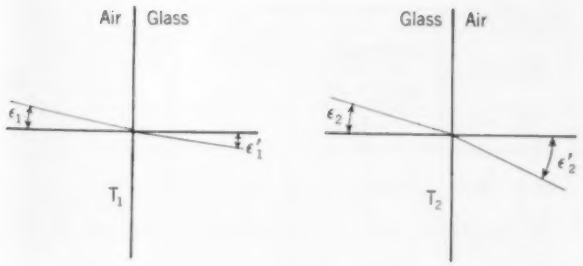


**Fig. 7. Chromatic aberration.**

To show this we will discuss the distortion of rays incident in a plane V which is perpendicular to the plane W of Fig. 6.

V forms an angle $\delta_1$ with the normal to $T_1$. The direction of an incident ray in V is determined by the angle $\epsilon_1$ with the plane W of the drawing. The angles which the projection of the ray on the plane W forms after refraction at $T_1$ and $T_2$ and reflection at the cylindrical mirrors $M_1$ and $M_2$ are indicated in Fig. 6. We now wish to know the deviation

$$\Delta\delta_2' = \delta_2' - \delta_{02}'$$

in which $\delta_2'$ and $\delta_{02}'$ are the projections on the plane W of the exit angles of two rays the first of which forms before the entrance at $T_1$ an angle $\epsilon_1$ with the plane W, while the second is situated in W. The deviation $\Delta\delta_2'$ is the sum of three contributions, viz. two on account of the refractions at the parallel planes $T_1$ and $T_2$, and the third because of the reflection at the pair of anamorphic mirrors $M_1$ $M_2$. The contribution to the deviation at $T_1$ is a consequence of the laws of refraction, according to which*:

$$\cos\epsilon_1 \sin\delta_1 = n\cos\epsilon_1' \sin\delta_1' \quad (8)$$

$$\sin\epsilon_1 = n\sin\epsilon_1', \quad (9)$$

where n is the index of refraction of the glass, while $\epsilon_1$ and $\epsilon_1'$ are the angles of the incident and refracted rays with W.

If $\delta_{01}'$ is the value of $V_1'$ for a principal ray situated in the plane W, we find by expanding (8) in a series of $\epsilon_1$ and $\epsilon_1'$, taking into account only the quadratic terms, and applying (9)

$$\Delta\delta_1' = \delta_1' - \delta_{01}' = -\frac{\epsilon_1^2}{2}\left(\frac{n^2-1}{n^2}\right)\operatorname{tg}\delta_1'. \quad (10)$$

After reflection at $M_1$ and $M_2$, there is added to this deviation the angle $\Delta\delta$ given by

$$\Delta\delta = \frac{\epsilon_1'^2}{2}(\beta^2 - 1)\operatorname{tg}\varphi. \quad (11)$$

This relation is equivalent to (2) in a medium with index of refraction n, as in Fig. 5 the distortion angle $\Delta\delta$ is for small angles $\epsilon$ equal to

$$\Delta\delta = \frac{p_0\cos^2\varphi'}{a_0} \text{ and } \epsilon = \epsilon_0\cos\varphi'.$$

Finally, on account of the refraction at $T_2$ there is added a deviation with opposite sign from that of the surface $T_1$ and which is $\beta^2$ times as great, as the angle between the ray and W is now enlarged by a factor $\beta$ due to the anamorphic system of mirrors $M_1$ and $M_2$.

The combination of the three deviations gives, after a simple computation

$$\Delta\delta_2' = \frac{\epsilon_1^2}{2n}(\beta^2 - 1)\frac{\cos\delta_{02}}{\cos\delta_{02}'}\left\{\operatorname{tg}\varphi + (n^2-1)\operatorname{tg}\delta_{02}\right\} \quad (12)$$

from which follows, for the relative curvature of a horizon projected on a screen perpendicular to the planes V and W, the expression

$$\frac{a}{r} = \left(1 - \frac{1}{\beta^2}\right)\frac{1}{n}\frac{\cos\delta_{02}}{\cos\delta_{02}'}\left\{\operatorname{tg}\varphi + (n^2-1)\operatorname{tg}\delta_{02}\right\}. \quad (13)$$

From these formulas we may conclude:

1. In the case of $\delta_1 = 0$ and hence the plane V of the incident rays perpendicular to the refracting surfaces $T_1$ and $T_2$, the distortion is reduced by a factor equal to the index of refraction n as compared with the mirrors in air (see relation (6)).

2. It is fundamentally possible to compensate the distortion of the pair of mirrors $M_1$ $M_2$. We will use this property to obtain a distortion-free Delrama, to be described hereafter.

3. In the limit when the planes $T_1$ and $T_2$ are parallel to the generatrices of $M_1$ and $M_2$ ($\varphi = \delta_{02}$) we obtain an expression equivalent to (6) which is independent of the index of refraction.

At first sight one would think that the incorporation of glass would introduce a noticeable chromatic aberration as a consequence of the different entrance and exit angles of the rays. This, however, is not the case. One can see this approximately as follows: if the plane V is perpendicular to $T_1$ and the incident rays impinge on the glass at an angle $\epsilon_1$, the refracted rays form an angle $\epsilon_1'$ given by (see Fig. 7)

$$\sin\epsilon_1 = n\sin\epsilon_1'. \quad (14)$$

This angle $\epsilon_1'$ will be increased to $\epsilon_2$ by reflection at the surfaces $M_1$ and $M_2$, so that

$$\sin\epsilon_2 = \beta\sin\epsilon_1' \quad (15)$$

and after refraction at $T_2$

$$\sin\epsilon_2' = n\sin\epsilon_2. \quad (16)$$

Thus we find

$$\sin\epsilon_2' = \beta\sin\epsilon_1 \quad (17)$$

* Czapski-Eppenstein; *Grundüge der Theorie der optischen Instrumente*, 3e Auflage, 1924, pp. 6 and 330-334.

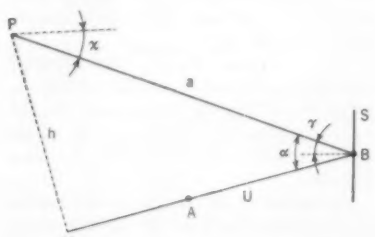


**Fig. 8. Distortion in the case of oblique projection on a curved screen.**

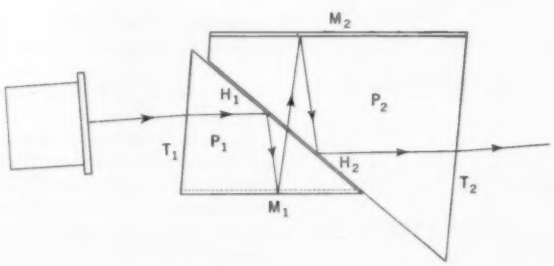


**Fig. 9. Delrama IV.**

and since the index of refraction does not enter into the relation (17), there will be no color shift in a horizontal direction. However, the relation (15) is not exactly valid and thus there will be a small chromatic aberration. Exact calculation shows that this aberration amounts to less than 10″ of arc between red C and blue F lines for the extreme rays in the case of a rhombohedron system as incorporated in a Delrama with an anamorphic factor of 2 used in combination with a lens $f = 50$ mm.

The color shift in a vertical direction follows from relation (12) by differentiation with respect to the index of refraction n.

For the same extreme rays as considered above we find a difference of 0.5′ of arc, corresponding to only 7 $\mu$ on the film, which is confirmed by exact calculation. The chromatic aberrations are thus negligibly small.

**Distortion in the Case of Oblique Projection on a Curved Screen and Its Compensation**

In many theaters the projection is oblique downwards. As a result the image of the horizon when projected on a curved screen is distorted upwards. This distortion can be compensated by applying a Delrama System with a downward distortion. The condition for this compensation for a spectator in the theater will now be deduced.

In Fig. 8 the projector P causes an image on the screen S, of which B is the center. The screen is cylindrically curved with a radius of curvature equal to $\rho_0$ and is tilted, the normal forming an angle $\gamma$ with the line PB. The spectator is at A, the angle ABP being $\alpha$.

If the spectator does not see the horizontal edges of the screen a projected horizon at B will give an impression of a straight line if all the lines connecting A with this horizon are in a flat plane U. In other words: compensation of distortion is obtained when the flat plane U intersects the cylindrical screen S in the same ellipse as the projected horizon. The latter is the intersection of S with a cone having its apex at P; this must be identical with the intersection of the cone with U.

The radius of curvature $\rho$ of the circle osculating the intersection ellipse of U and S at its apex is given by

$$\rho = \rho_0 \cos(\alpha - \gamma) \qquad (18)$$

The radius $r_u$ of the circle osculating the intersection of U with the projected cone is given by

$$r_u = r \sin \alpha \qquad (19)$$

if we define r as the radius of curvature of the horizon, projected on a flat screen perpendicular to the line PB. The expression for the relative distortion a/r is given in (13), in which a is the projection distance.

Now compensation is attained if $r_u = \rho$, thus giving the relation

$$\rho_0 \cos(\alpha - \gamma) = r \sin \alpha . \qquad (20)$$

From (13) and (20) the values of the angles $\varphi$ and $\delta_{02}$ can be calculated at given values of the anamorphic magnification $\beta$, the angles $\alpha$ and $\gamma$ and the radius $\rho_0$.

In many practical cases $\cos(\alpha - \gamma)$ is to a sufficient approximation equal to 1. Moreover, the radius of curvature $\rho_0$ of the screen S is often assigned a value equal to the projection distance a. Then (20) changes to

$$\sin \alpha = \frac{a}{r} \qquad (21)$$

Let us take as an example a theater with the following characteristics.

Distance a = 20 m

Downward projection angle $\chi = 14°$

Focal length of objective = 100 mm

Seat of a spectator A at the center and at the same horizontal level as the bottom part of the screen.

As the distance from A to S is 10 m, we find for the angle $\alpha$ a value of 24°. In the case of the two-mirror Delrama as sketched in Fig. 2, having an anamorphic ratio $\beta = 2$, we find for the required angle $\varphi$:

$$\operatorname{tg} \varphi = \frac{3}{4} \sin 24°, \text{ and hence } \varphi = 28° .$$

If the compensation is realized for the center B of the screen, the projection of the upper horizontal line will be seen curved upwards and that of the lowest line downwards. Now in most theaters the faintly illuminated edges of the screen can be observed. The psychological impression of the curvature of horizontal lines is much influenced by whether these are parallel or not to the edges of the screen, parallelism helping to give an impression of the absence of distortion. Thus best results will probably be obtained by making the horizontal edges of the screen coincide with the top and bottom projected horizontal lines of a film taken with an anamorphic system in combination with an objective of 50 mm.* In this way the inherent distortion of the horizontal extreme lines in the film image is also dealt with.

**Distortion-Free Delrama System**

The distortion which is an advantage when projecting downwards in a cinema theater is a disadvantage in other circumstances and especially during the taking of a film. It can, however, be eliminated in a simple way. Moreover, it is then possible to deal with the shifting of the rays, which amounts to 12 cm in the case of the two-mirror projection

* The distortion of the film image is dependent on the field angle and hence on the focal distance. Lenses with 50mm focal length are used in most exposures.

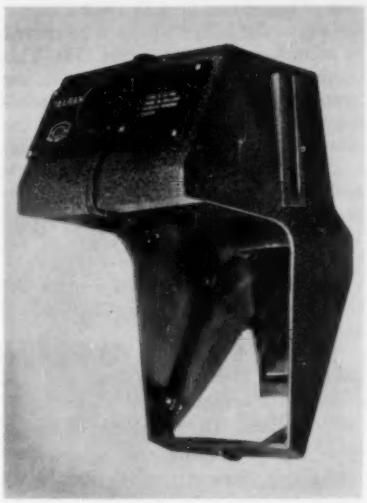

**Fig. 10. Delrama II 35mm.**

Delrama for 35mm film having an anamorphic ratio of 2.

The optical system may be described with the aid of Fig. 9. The light from the projector enters a prism $P_1$ at the plane surface $T_1$, is totally reflected at the hypotenuse $H_1$, and afterwards at the concave cylindrical mirror $M_1$, can now pass the hypotenuse because of the change of angle due to the reflection at $M_1$ and enters prism $P_2$. Then the light is reflected at the convex cylindrical surface $M_2$ and afterwards by total reflection at the hypotenuse $H_2$, leaving the system at $T_2$.

Focusing at finite distances is obtained by shifting the prism $P_1$ along the surface $H_2$ thus altering the distance between $M_1$ and $M_2$.

According to (13) the distortion is eliminated if

$$\operatorname{tg} \varphi + (n^2 - 1) \operatorname{tg} \delta_{02} = 0 . \qquad (22)$$

If a system with an anamorphic ratio $\beta$ equal to 2 suitable for a lens with focal length of 50 mm and film image of 23.2 × 18.2 sq mm is made of borium crown glass (n = 1,517) the angle $\varphi$ amounts to 8°15′ and we find from (22) for $\delta_{02}$ the value 6°15′ or for $\delta_{01}$ 9°30′.*

**Comparison of the Distortion of Other Systems**

In the preceding section the term "distortion free" has been used. This term refers to the property of a system of representing a horizontal straight line at the center of the film image after projection on a flat screen as an actual horizontal straight line. However, the projec-

* The curvature of the horizon can also be eliminated by combining two Delrama Systems with opposite distortion. If the relative distortions of the first and the second system are $(a/r)_I$ resp. $(a/r)_{II}$′ and the anamorphic ratio of the second is $\beta_{II}$, we find:

$$a/r = \{(a/r)_I + \beta_{II}^2 (a/r)_{II}\}/\beta_{II}^2$$

tion of horizontal lines at the bottom or the top of the image will then be curved in accordance with (12) and (13). This distortion is also a property of the anamorphic systems composed of cylindrical lenses or of Brewster prisms; the relative distortion curvature is in these cases also given by (6) if $\varphi$ is the angle between the rays and a plane perpendicular to the generatrices of the cylindrical lenses or to the parallel edges of the prisms. The same derivation of (6) may be given as the angle $\varphi$ will remain the same after the light ray has passed through the system.

There is, however, a difference between the Delrama System and the others with respect to the distortion of vertical lines. The Delrama of Fig. 2 with the two mirrors in air provides completely straight vertical lines in the image as follows immediately from the fact that the geometrical projection of the rays on a plane perpendicular to the generatrices of the mirrors is independent of the angle of the rays with these generatrices.

With the all-glass Delrama of Fig. 6 or Fig. 9 there is a very small distortion, which can be deduced along the same lines as the relation of formula (13). We find:

$$\frac{a}{r_\perp} = n^2(n^2 - 1)\left(\frac{\cos \epsilon_2}{\cos \epsilon_1'} - 1\right) \operatorname{tg} \epsilon_2' \qquad (23)$$

in which $r_\perp$ is the radius of curvature of a projected vertical line on a curved screen with radius equal to a and which is perpendicular to the central ray of the image.

For the most disadvantageous case of a Delrama for 35mm film with anamorphic ratio 2 as given in Fig. 9 in combination with a lens with focal distance of 50 mm, we find for the relative curvature of a border line $a/r_\perp = 0.06$, corresponding to a linear aberration in the film image of only 0.05 mm.

With an anamorphic system consisting of two thin cylindrical lenses of refractive index n we find

$$\frac{a}{r_\perp} = \left(1 + \frac{1}{n}\right)(\beta - 1) \operatorname{tg} \epsilon. \qquad (24)$$

If $n = 1.5$ this corresponds to $a/r_\perp$ equal to 0.38 for the same image lines as above.

In principle it must be possible to correct this curvature. A cylindrical lens system as used in cinema projection proved not to be corrected in this respect, the curvature also being 0.38. This rather pronounced curvature, however, constitutes no inconvenience in most cases.

**References**


1. D. Brewster, *A Treatise on Optics*, London, 1831, pp. 363–365.
2. P. Rudolph, Br. Pat. 8512, March 18, 1899.
3. G. J. Burch, *Proc. Royal Soc.*, 74 (1904).
4. Les anamorphoseurs, 1930, 3e Réunion de l'Institut d'Optique, Paris.
5. First patent application in the Netherlands, June 10, 1953.


[*Editorial Note:* One reviewer has advised as follows: The credits might be expanded to include some important early work. For example, the British Patent to Rudolph (ref. 2 above) was anticipated by British Patent 1453 in the year 1862 to Leon Farrenc. Also, an Italian, Ernesto Zollinger (U.S. Pat. 1,032,172 of 1910), suggested a lateral squeezing and unsqueezing of a motion picture before Chrétien (ref. 4 above), although it is probably true to say that Chrétien was the first actually to accomplish this in practice.

The system shown in Fig. 9 (Delrama IV) is currently being marketed in this country under the name of Vistascope, with anormorphic magnifications of 1.5× and 2×.]

# Recent Developments in Anamorphotic Systems

A REPRINT

By G. H. COOK

At the present time the cinema industry is in the midst of changes which are almost as revolutionary as the introduction of talking pictures in the 1920's.

Anamorphotic optical systems are playing an important part in these changes and this paper will endeavor to describe the reasons for their presence and the types of system which are being adopted.

The term *anamorphosis* as applied to optical systems implies an arrangement in which image formation occurs on different scales in the vertical and horizontal directions. There is, therefore, at some stage between camera and theater screen, deliberate distortion of the original scene which must be compensated for before the picture can be viewed in the theater.

The use of anamorphotic systems in itself does not provide any startling change to the appearance of screen pictures. It is a means of providing wide-screen pictures of the so-called panoramic type whilst avoiding some of the practical difficulties which prevent conventional systems from providing an adequate standard of performance.

The limitations on the dimensions of large screen are set by the width available within the architecture of the theater and for height by sight lines from the rear of the stalls seats past the overhang of the balcony. These limitations, and to a smaller degree the desirability of avoiding extreme picture height for viewers near the screen, have resulted in the adoption of picture formats whose aspect ratio, width to height, is up to twice the conventional ratio of $1\frac{1}{3}$ to 1 which has been a standard for many years on small screens.

The sponsors of wide aspect ratios argue that they permit the composition of a more interesting picture, especially if the scale of the image detail on the screen is maintained near its normal value by the use of wider angle camera lenses embracing more extensive fields of view. The claim that the panoramic screen gives an illusion of depth is not substantiated by any optical characteristic of the screen image and can only be due to what has been called extra "audience participation" within the scope of a more extensive picture.

Reprinted from *British Kinematography*, **25**: 61–69, Mar. 1955, by permission of the British Kinematographic Society, and with the cooperation of the author, G. H. Cook, Development Dept., Taylor, Taylor & Hobson Ltd., Stoughton St., Leicester, England. Mr. Cook presented this paper on December 15, 1954, to a meeting of the Theater Division of the British Kinematographic Society.

### Difficulties of Wide-Screen Projection

When an attempt is made to produce these large, wide aspect, screen pictures by conventional means and by standard projectors, two serious difficulties are encountered. One is due to the fact that the extra screen width has to be provided by shorter focal length projection lenses; that is, the optical magnification between the film and the screen is increased and imperfections due to the presence of emulsion grain or lack of definition on the film are exaggerated.

The second difficulty is due to the fact that the projector picture aperture has to be cropped, top and bottom, to provide the wider picture aspect ratio and there is therefore less light passing through this smaller aperture to illuminate a larger screen.

The visibility of the screen picture depends on a number of factors but, assuming adequate illumination and the use of a perfect projection lens, it depends mostly on the information stored on the film. The presence of grain in the film either direct or reproduced from negative grain, plus the presence of camera lens aberrations and depth of field considerations, has the effect of limiting the amount of picture information that can be stored on the film. Taking an average resolving power of 50 lines and spaces per mm for the camera lens and film combination, we can consider the film image as a mosaic in which there are 100 individual picture elements per mm. When this is projected at a magnification of 500 times onto a 35-ft wide screen the screen picture is a mosaic where the size of each individual picture element is about $\frac{1}{4}$ in. The visual acuity of the human eye is sufficient to discern this degree of softness of the image at distances up to about 35 ft from the screen.

The brightness of the screen image for any constant screen area is directly proportional to the total luminous flux passing through the projector gate. If the area of the gate were reduced by cropping top and bottom, the total luminous flux passing through it from the same arc lamp would be reduced proportionately and, if this illuminated the same or a larger screen area, screen brightness would be reduced.

Both these types of difficulties relating to grain size, definition and illumination can be reduced by the use of anamorphotic projection systems. The variation of optical magnification in vertical and horizontal directions permits the projection of wide aspect ratio pictures from projector gates whose dimensions make good use of the picture area available on standard positive 35mm film. The largest area that can be recorded on the film and projected by a standard projector has an aspect ratio of about $1\frac{1}{4}$ to 1. If all this area is to be projected on a screen having the CinemaScope aspect ratio of $2\frac{1}{2}$ to 1, the optical projection magnification must be twice as great horizontally as it is vertically.

To maintain correct geometrical reproduction of the original scene, the image on the positive film must be unnaturally compressed so that its scale horizontally is half its scale vertically. Thus, if the original object seen by the camera was a circle, then the image on the positive film must be an ellipse, with its horizontal axis half its vertical axis. This ellipse on the positive film will be projected onto the screen as a circle.

### Anamorphotic Reduction of Negative Grain

The slide (page 152) demonstrates in an approximate manner the anamorphotic reduction of the effects of negative grain and definition. These effects can be simulated by breaking up the image into a mosaic where the individual picture elements correspond to the maximum storage capacity of the film. These projected images are enlarged considerably and should be considered as very small detail within a large-screen picture. To the left (a) is the screen image which would be produced by straightforward projection at high magnification from a cropped positive picture area, and the coarse picture mosaic is seen to have equal vertical and horizontal pitch. Center (b) of the slide is the image which would be produced by anamorphotic projection onto the same screen and the horizontal magnification is therefore the same as for the lefthand image. The vertical magnification from a maximum area projector gate, and thus from a large film area, has been halved and in the vertical direction there are therefore twice as many elements per unit height. The overall effect of the right-hand image shows an improvement in apparent definition. These images have been obtained in an arbitrary manner which assists reproduction and the apparent variations in contrast should be ignored.

(a) (b) (c)

**Slide (a) no camera anamorph, no printer anamorph, no projector anamorph; (b) X2 camera anamorph, no printer anamorph, X2 projector anamorph; (c) no camera anamorph, X2 printer anamorph, X2 projector anamorph.**

The method is analogous to optical imagery and can illustrate the features described above.

### Increased Luminance

[Increased screen brightness with anamorphotic projection was demonstrated by first projecting a wide aspect ratio screen area from a top-and-tailed projector gate, and then by projecting a similar screen area anamorphotically from a normal gate having twice the height. A considerable increase in brightness was observed.]

Having described the basic reasons for the use of anamorphotic systems we can consider the various systems that are available for this purpose.

### Available Anamorphotic Systems

Since the screen picture has to be increased in width it is convenient to use supplementary wide-angle attachments in front of conventional projection lenses. To achieve the desired anamorphotic effects the attachment must have telescopic power horizontally and no telescopic power vertically.

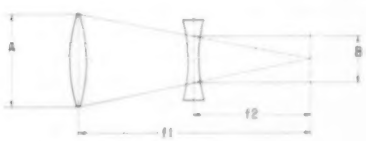


**Fig. 1. Simple telescope system.**

$$\text{Telescopic Power } \frac{f1}{f2} = \frac{A}{B}$$

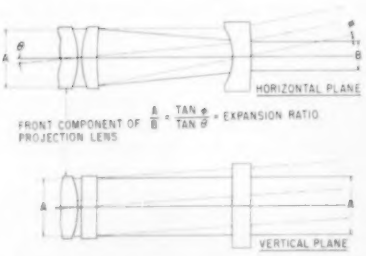


**Fig. 2. Layout of cylindrical system used for anamorphotic projection.**

Consider a simple telescope system such as that used in opera glasses. When the separation between the collective and dispersive components is equal to the difference between the focal lengths of the two components, parallel light entering at one end emerges from the other as parallel light. The telescopic power is then defined by the ratio of the two focal lengths $f_1/f_2$ and considering the geometry of this arrangement it can be shown that telescopic power can also be defined by the ratio of the entrance and exit beam diameters A/B (Fig. 1).

If such a system has a telescopic power of 2 and it is positioned in front of a conventional camera or projection lens with its collective component near the lens, it will reduce the focal length of the combination by a factor 2 and double its angular field of view. Although the beam width is reduced according to the telescopic power, the focal length of the combination is reduced by the same factor and there is therefore no change in relative aperture or *f*/number.

### Cylindrical Anamorphotic Attachments

If the lens surfaces in such a telescope were cylindrical in shape instead of spherical, the system could have a telescopic power of 2 in the horizontal direction and have unit power vertically.

Figure 2 indicates the layout of a cylindrical system used for anamorphotic projection. The ratio A/B defines the telescopic power in each plane and the increased angular field is also indicated by the inclination $\theta$ of an oblique beam emerging from the projection lens and the inclination $\varphi$ of the same beam emerging from the cylindrical attachment. The ratio $\tan \varphi / \tan \theta$ is equal to A/B. In a vertical plane the lens surfaces are straight and parallel. A equals B and $\varphi$ equals $\theta$ and there is therefore no change of focal length or angular field.

The optical design of this type of system requires just as much attention as the design of normal camera or projection lenses and the adequate correction of all aberrations can be achieved by the use of complex lens constructions comprising more than one lens element in each of the front and rear components.

The advantages of cylindrical anamorphotic attachments for cinema projection were first proposed and demonstrated by Professor Chrétien in France some 25 years ago. The recent adoption of the method on a large scale has encouraged the development of a variety of cylindrical constructions by manufacturers in many countries.

[The type of performance provided by a cylindrical anamorphotic attachment was demonstrated.]

### Prismatic Anamorphotic Attachments

In the search for alternative solutions to the optical problems involved in the

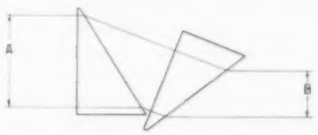


**Fig. 3. Optical principle used in the prismatic anamorph.**

$$\text{Telescopic Power} = \frac{A}{B} = \text{Expansion Ratio}$$

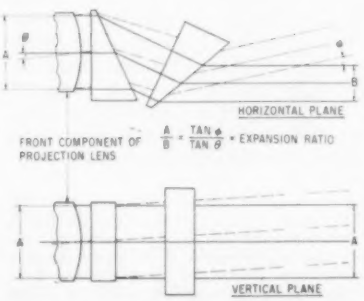


**Fig. 4. The prismatic anamorphotic attachment.**

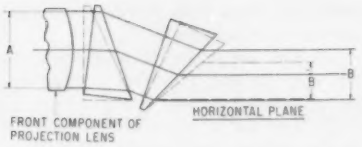


**Fig. 5. Prismatic anamorphotic attachment. Variable Expansion Ratio.**

design and manufacture of cylindrical systems, widespread use has been made of constructions employing prismatic components instead of lens components.

Figures 3 and 4 illustrate in a very simplified form the basic optical principle utilized in prismatic types of attachments. It comprises two wedge-shaped prisms inclined with respect to the light path in such a way that, in the horizontal plane, the ratio between the entering and emerging beam widths fulfils the requirements for telescopic power as defined previously. By suitably inclining the two prisms in opposite directions, the emergent beam can be made parallel to the entrant beam (Fig. 4). In the vertical plane the flat polished surfaces of the prism are parallel to one another and therefore have no effect.

Prismatic attachments have one big advantage over all other types. They are readily adaptable to a form wherein the inclinations of both prisms may be adjusted to provide a range of telescopic power and thus varying degrees of picture expansion (Fig. 5). This form will be of use to the exhibitor when he has to project different degrees of image compression. He thus avoids the necessity of using a number of different attachments each providing one fixed expansion ratio.

Although the opposed inclinations of two prisms provide correction for primary color aberrations, higher order color aberrations are excessive and such simple systems cannot yield useful results. Furthermore, as a result of other aberrations the telescopic power varies across the field of view and results in distortion of the image.

Adequate correction of distortion and color aberrations can be obtained by replacing the simple prisms by more complex forms.

The arrangement shown in Fig. 6 can be considered as the simplest construction to give an adequate performance at a fixed expansion ratio of about 2. This diagram also indicates a somewhat more complicated variable form which provides the same standard of performance over a small range of expansion ratios.

[The prismatic developments thus illustrated were demonstrated first by the projection of a test object through simple uncorrected prisms. The color aberration was excessive and it was explained that had the projection been over a wider screen a variation of expansion across it would have been noticeable as a distortion of the image. The correction of these two errors was shown by projection through a standard prismatic attachment whose expansion ratio was fixed at the factor 2 required for CinemaScope. Using the variable type, the performance was maintained over a range of expansion ratios from about 1.4 to 2 (Fig. 6).]

### Focusing Varying Screen Distances

One important feature arising from the use of all types of anamorphotic systems is the means adopted for focusing different screen distances. The combined system of projection lens and attachment has different focal lengths in the vertical and horizontal planes. Since focusing movement of a lens is a function of its focal length, no single movement of the projection lens alone can focus simultaneously vertical and horizontal lines on the screen. In the case of cylindrical systems two adjustments are necessary, one to the projection lens in the normal manner and the other to the component separation in the cylindrical attachment.

In the case of prismatic attachments the separation between components has no effect on focusing. Correct focus can only be achieved by setting the projection lens focused for an infinitely distant screen and utilizing at the front of the attachment a further supplementary lens system whose focal length can be adjusted to equal the screen distance. This arrangement fulfils the condition that parallel beams of light enter and emerge from the prismatic attachment. The complete arrangement is shown in Fig. 7.

Some variable prismatic attachments being made in other parts of the world do not include supplementary focusing lenses. The errors of focusing which result are only dependent on the ratio of the two focal lengths and thus the expansion ratio. The actual form adopted for the prismatic components can have no influence on this effect.

[To illustrate the necessity of providing suitable focusing means, an image was projected through a variable attachment correctly focused for the screen distance in the theater at Film House. The equal definition on vertical and horizontal lines was noted, and it was also observed that both horizontal and vertical lines went in and out of focus simultaneously. Then an image was projected through an identical system whose supplementary focusing arrangement had been removed. It was seen to be impossible to achieve simultaneous focus for vertical and horizontal lines, and that the errors increased with increased expansion ratio. The demonstration clearly proved that whilst the focusing arrangement does add to the cost of the equipment and results in greater weight and slightly increased absorption of light, it is necessary if an adequate standard of definition is to be obtained.]

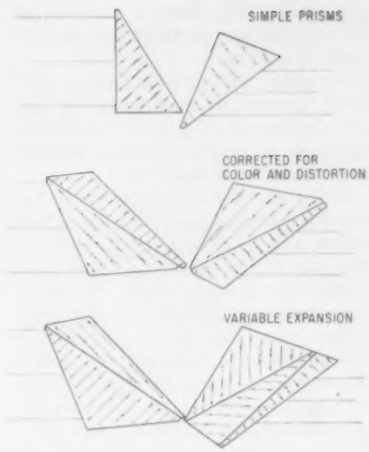


**Fig. 6. Prismatic anamorphotic attachments.**

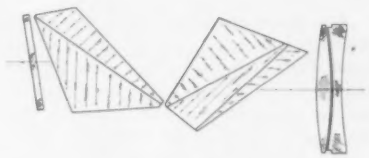

**Fig. 7. Arrangement of prismatic projection attachment.**

In view of certain misconceptions which have arisen amongst exhibitors, it is important to stress that a variable anamorphotic lens should only be used to restore the particular compression incorporated in the release print being projected. A change in aspect ratio of the screen picture can only be obtained by masking in the gate aperture of the projector. The size of an object appearing on the screen is governed solely by the focal length of the projection lens selected. Only one expansion ratio restores the geometry of picture detail and an acceptable picture cannot be obtained when the aspect ratio of the picture is altered solely by means of the anamorphotic expansion ratio.

### Screen Illumination

At the beginning of this discussion it was stated that anamorphotic projection permitted the use of larger projector gate apertures and resulted in improved definition and illumination. The improvement in definition exists at all expansion ratios but the gain in screen illumination is most apparent at large expansion ratios such as the factor 2 used for CinemaScope.

In comparing the illumination on the same screen area provided, firstly, by normal projection from a cropped gate and, secondly, anamorphotic projection from a maximum area gate, allowance has to be made for the extra light losses by absorption and reflection within the

attachment. It is useful to know where the illumination provided by the two methods is equal.

Assuming that the maximum gate width is constant the amount of light passing through the gate will be proportional to its height and thus inversely proportional to its aspect ratio.

If the gate for anamorphotic projection has maximum height its aspect ratio will be about 1.25 to 1. It can be shown that the two methods will give equal screen illumination when the screen aspect ratio is 1.25 divided by K where K is the proportional light transmission in the attachment. Prismatic attachments transmit about seven-tenths of the available light so that the two methods give equal illumination at screen aspect ratios of 1.25 divided by 0.7, i.e. about 1.8 to 1. Above this ratio anamorphotic projection gives brighter screens.

### The Projection Lens

This discussion would not be complete without reference to the projection lens itself. Poor definition arising from poorly corrected projection lenses is magnified by the anamorphotic attachment in the same proportion as the expansion ratio.

[To demonstrate this, an image was screened by the type of projection lens which has been standard cinema equipment for a considerable number of years. It was pointed out that although its simple construction provided an adequate standard of definition in the center of the screen, field curvature and astigmatism set a limit to definition at the edges. Such marginal errors enlarged by anamorphotic attachments are not acceptable on very large screens. The need for improvement has resulted in the introduction of a new range of lenses of high definition. The degree of improvement now available was demonstrated by a screen image projected with a new lens of the same focal length.]

The development of anamorphotic systems is still in its infancy, but as far as the cinema exhibitor is concerned, the equipment now available for use on standard projectors will be adequate for a number of years.

### Release Prints

The most severe optical problems occur in the processes used to produce release prints. When attachments which function in the described manner are used at the camera stage to record on the negative a compressed picture, they have to provide angular fields of view considerably greater than those required in cinema projection. To add to the difficulties, the camera attachment is also required to give good definition over a considerable range of object distances from infinity to close-ups. At the present time it is thought that cylindrical types of attachments are the only constructions that can perform under such extreme conditions and they are being developed in forms which utilize more complex and more numerous components compared with the relatively simple constructions used for projection. The use of large anamorphotic attachments on a studio camera and the associated loss of light by absorption and scatter presents its own problems.

The small studio may have limited camera and processing facilities and under these conditions it appears that the use of camera anamorphotic attachments provides the easiest method of producing anamorphotic prints.

On the other hand, the larger studios are not always limited in this manner and looking into the future, it may be that they will use cameras with larger negative areas to photograph wide-angle scenes in the usual way. The straightforward negatives so produced can then be compressed at an optical printing stage to provide compressed release prints for cinema projection. The advantages of such a process would be:

(1) The use of normal-type camera lenses avoiding the light losses, definition losses and extra bulk arising from anamorphotic attachments.

(2) The use of larger negative areas whose grain and definition is improved by reduction printing.

(3) The use of anamorphotic systems at the printing stage where the angular fields to be covered can be small and where they need only work at fixed conjugate distances, and

(4) The ability to use one negative for the subsequent production of release prints compressed in any ratio to suit any screen aspect ratio or, alternatively, for the production of normal prints.

When it is realized that positive emulsion has finer grain and can store more picture information than negative emulsion, the advantages of optical reduction between negative and positive become obvious. It has in fact been well demonstrated in the VistaVision process and the advantage applies equally well to anamorphotic printing.

Some of these advantages are shown on the slide illustration which has been referred to in an earlier section of this paper. Screen image (c) would be produced from a large straight-forward negative which has been anamorphotically compressed by a factor of two at the printing stage and then projected in the same manner as image (b). It can be seen that the horizontal printing compression has reduced the horizontal mosaic and this, in conjunction with the reduced vertical mosaic due to anamorphotic projection, gives a further improvement in picture visibility compared with image (b).

### Acknowledgments

In conclusion, I would like to thank Messrs. Taylor, Taylor and Hobson Ltd. for permission to read this paper, G.B.-Kalee Ltd. for the loan of equipment, and the staff at Film House for their practical assistance. Thanks are also due to my colleague Mr. Green for his suggestions and co-operation in the slide-projection box.

# Modern Cine Camera Lenses

By G. H. COOK

THE LENSES used in motion-picture cameras are almost invariably of wide relative aperture and the sharpness of the recorded film images must permit very considerable magnification onto large viewing screens.

These and other factors present a series of optical problems which are more severe than those encountered in other branches of photography. In recent times this situation has been aggravated by the demand for wider angles of view at the camera and even larger magnifications for bigger screens and wider screens.

The modern cine camera lens does provide a very high standard of definition and we have almost reached the stage where improvement of emulsion characteristics and greater film stability in the camera are necessary, if good use is to be made of further improvement of camera lenses.

### Reduction of Grain Effects

In the professional field, it has been suggested that the effects of negative emulsion grain can be reduced by the use of larger negative areas which are subsequently reduced onto standard positive frame areas. The adoption of this rather cumbersome arrangement illustrates the need to look beyond the lens for improved performance.

The reduction of these grain effects achieved by this method is largely due to the greater information storage capacity of positive emulsion compared with negative emulsion. The presence of grain in the positive film, either direct or reproduced from the larger negative grain, plus the presence of camera lens aberrations and depth of field considerations, has the effect of limiting the amount of picture information that can be stored on the film. Taking an average resolving power of 50 lines/mm, i.e. 50 lines and spaces, for the camera lens and negative film combination, we can consider the film image as a mosaic in which there are 100 individual picture elements per mm. When this is projected at a magnification of 500 times onto a 35-ft wide screen the screen picture is a mosaic where the size of each individual picture element is about a $\frac{1}{4}$ in. The visual acuity of the human eye is sufficient to discern this degree of softness of the image at distances up to about 35 ft from the screen.

If the same standard of resolution could be recorded on a larger negative area, then the optical printing reduction to provide a standard-sized positive release print will reduce the size of the individual picture elements and there will be consequently more picture elements per unit area. Thus for example in the VistaVision process, where the optical reduction factor from negative to positive is 1.6, the resolution available for recording in a fine-grain positive emulsion can be 1.6 times 50 lines/mm, i.e. 80 lines/mm.

### The Use of Large Negative Areas

It might be thought that the adoption of large negative areas presents no serious problems to the lens manufacturer, since existing lens designs can be scaled up to provide the same angular field coverage at longer focal lengths. There are two major factors which detract from the usefulness of this line of attack. One concerns the avoidance of an uncomfortably large scale of image dimensions on the screen and the other concerns depth of field. Both factors indicate that the most useful range of focal lengths covering large negatives will correspond to a range of angular fields of view which are wider than those which have been used in the past on conventional cameras and for small-screen pictures.

All the new cinema techniques, including CinemaScope and VistaVision, depend for their effect to a large extent on the use of a large theater screen. The mere increase of optical projection magnification to achieve this result is undesirable, since the linear scale of individual objects on the screen becomes unpleasantly large. The use of wider angles of view at the camera restores the scale of detail in the screen image towards its conventional proportions and permits the composition of a more interesting picture.

### Effects on Depth of Field

The VistaVision process provides a useful basis for comparing the effects of large negative areas on depth of field considerations. Present studio practice has evolved to the point where depth of field is handled according to experience as well as by numerical calculations and since it is the sharpness of the theater screen image which sets a limit on depth of field rather than the sharpness of either the negative or the positive film picture alone, it is advisable to avoid any reference to an arbitrary standard in terms of disk of confusion and to make the comparison between theater screen depth of field assuming a constant criterion for performance in one theater. In the following comparison the word "conventional" refers to 35mm cameras with standard sound aperture gates and projection onto prewar screen sizes.

Imagine the same scene photographed and projected first by the conventional method, and secondly by the VistaVision process. It can be assumed that the VistaVision picture is projected onto a larger screen, whilst the linear scale of picture detail remains unaltered. This arrangement is achieved when the VistaVision camera focal length and the camera viewpoint position is the same as for the conventional camera, and the theater projection magnification is 1.6 times the conventional magnification. The factor 1.6 is of course the optical reduction factor between the large VistaVision negative and the positive release print. The depth of field in the negative will be the same as normal because camera lens focal lengths and apertures are identical. The optical reduction of 1.6 at the printer stage can reduce the size of the disk of confusion on the positive print by about the same factor and, since this smaller disk is magnified onto a screen 1.6 times as large as the conventional screen, the sharpness of far and near images on the screen will remain at the conventional level and the apparent depth of field of the two processes is identical under this set of conditions for a constant viewing position in the auditorium.

There are three main variations from these assumed conditions. The first concerns a change of camera lens focal length. If the focal length is increased by a factor 1.6, the field of view will be the same as that obtained in conventional practice from the same camera viewpoint. This results in a reduction in depth of field at all stages of the process of about $1.6^2$, i.e. 2.6, for the same relative aperture and disk of confusion. It can be stated therefore, that in the two systems being compared, depth is inversely proportional to the square of the

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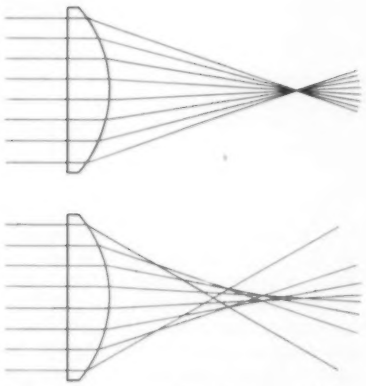


**Fig. 1. Comparison of perfect lens (above) with lens having spherical aberration (below).**

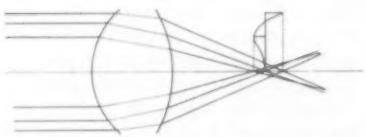


**Fig. 2. Diagrammatic illustration of spherical aberration.**

ratio between VistaVision camera focal length and the conventional focal length, for the same scene shot from the same viewpoint at the same relative aperture.

Secondly, the two focal lengths can remain the same and the VistaVision camera viewpoint distance be shortened by a factor 1.6 to include the same field of view. Again, depth will be reduced by approximately $1.6^2$, i.e., 2.6 for the same relative aperture and disk of confusion. It can be stated therefore, that in the two systems being compared, depth is directly proportional to the square of the ratio between VistaVision and conventional camera viewpoint distances for the same focal length at the same relative aperture.

Thirdly, the VistaVision screen size will vary very considerably. In the idealized comparison just described it was assumed that the VistaVision screen was 1.6 times as wide as that for the conventional picture. In large theaters it may be desirable to provide a larger picture and in some theaters such large pictures are impossible. If projection magnification is the only variable in our comparison, the sharpness of far and near images on the screen, and thus the depth of field for one viewing position in the auditorium, will increase directly with decreased screen size.

The effect of these three variations is summarized in Table I.

It shows how VistaVision depth of field can be expected to vary from that obtained in conventional 35mm film presentation on the old small screen. Figures exceeding unity indicate a proportional increase of depth of field. The values for S are the ratio between VistaVision and conventional screen widths. The values for F are the ratio between VistaVision and conventional camera lens focal lengths, maintaining the same camera viewpoint distance. The values for V are the inverse ratios between VistaVision and conventional camera viewpoint distances, maintaining the same camera lens focal length. Since the effects of F and V are similar, they are listed together. The table shows how depth of field of the VistaVision process can be maintained at or above the conventional level by restricting camera lens focal lengths or by putting the camera viewpoint further from the object. Since the latter is inconvenient in studios, an adequate depth of field is best obtained by the use of shorter focal length camera lenses. It should be realized that the conventional level of depth of field on the large VistaVision theater screen may be undesirably low, since a wider angle scene will usually contain a larger number of objects outside the plane of maximum interest. The adequate illumination of large studio sets presents its own problems and there will be further reductions in depth of field if VistaVision camera lenses are used at wider relative apertures than hitherto.

The preceding remarks indicate therefore that one of the new problems that has to be solved by the lens manufacturer is the design and production of lenses which can provide a very high standard of definition when working over wide angular fields of view at wide relative apertures. The solution of this problem will provide the basis for improved lens performance for standard 35mm cameras with sound or silent gate apertures and also for 16mm cameras.

**Table I. The Effect of the Three Main Variations From Ideal Conditions.**

| | Ratio $\frac{\text{VistaVision Depth of Field}}{\text{Conventional Depth of Field}}$ $S =$ | | | | | |
|---|---|---|---|---|---|---|
| F or V | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 |
| 1.6 | 0.62 | 0.52 | 0.45 | 0.39 | 0.35 | 0.31 |
| 1.4 | 0.81 | 0.68 | 0.58 | 0.51 | 0.45 | 0.41 |
| 1.2 | 1.10 | 0.92 | 0.79 | 0.69 | 0.61 | 0.55 |
| 1.0 | 1.60 | 1.33 | 1.14 | 1.00 | 0.89 | 0.80 |
| 0.8 | 2.49 | 2.08 | 1.78 | 1.56 | 1.39 | 1.25 |
| 0.6 | 4.43 | 3.69 | 3.16 | 2.77 | 2.46 | 2.22 |

$$S = \frac{\text{VistaVision Screen Width}}{\text{Conventional Screen Width}}$$

$$F = \frac{\text{VistaVision Camera Focal Length}}{\text{Conventional Camera Focal Length}} \quad (V = 1)$$

$$V = \frac{\text{Conventional Camera Viewpoint}}{\text{VistaVision Camera Viewpoint}} \quad (F = 1)$$

**Lens Aberrations**

In discussing the exact nature of these problems and their possible solution, it will be necessary to describe the errors or aberrations which are present to varying degrees in all lenses.

The errors referred to in this connection are those which are unavoidable on theoretical grounds and are not to be confused with defects which may result from faulty workmanship or accidental damage.

**Spherical Aberration**

One of the imperfections is spherical aberration, which concerns object and image points lying on the axis of the lens. The rays of light reaching the lens from an infinitely distant object point are parallel to its axis and to one another. If the lens were perfect, all the rays would be converging upon a single point focus. No single collective lens can act in this manner if its polished surfaces are spherical in shape. This can be demonstrated by simple geometry and that fact explains the reason for the name spherical aberration. Lens surfaces have to be made to a very high order of accuracy and departures from the ideal are measured in terms of a few millionths of an inch. In mass production the desired precision is most easily obtained on spherical surfaces and it follows that spherical aberration becomes an important limitation on lens performance. Figure 1 illustrates how rays from the marginal zones of a simple lens cross its axis closer to the lens than do the rays from intermediate zones.

When the lens construction is more complex and it contains at least one collective and one dispersive element, it is possible to correct the spherical aberration of rays passing through one annular zone of its aperture. Rays entering the lens at other zones cross its axis in front of or behind the point where rays close to the axis and rays through the corrected zone come to a focus. Figure 2 illustrates the conventional way in which this aberration is indicated in a diagram. These diagrams present a clearer picture of the extent of the aberration than would be possible by any other means and since use will be made of such diagrams later, it is necessary to explain them fairly carefully. The vertical scale represents the distance between a ray and the lens axis and is thus a measurement of relative aperture. The spherical aberration for each ray distance from the axis is measured along the lens axis as a percentage of the focal length and it is plotted on a greatly exaggerated scale in the horizontal direction at the appropriate position on the vertical scale. When the errors are zero for one zone of the lens aperture and over and under correct about the focal plane for other zones in the manner shown, we say that

the spherical aberration is corrected or balanced and the residual errors for the other zones are called zonal spherical aberration. The performance of the lens in the center of the picture will depend very largely upon the size of these residual errors. It is apparent from the diagram that any increase in relative aperture of this lens introduces marginal rays which are very badly over corrected and if the same standard of performance be required, the lens must be made more complex in construction in order to maintain residual aberrations within acceptable limits.

The effect of these residual spherical aberrations is shown in Figure 3. Both these patches are images of an illuminated pin hole made with the same lens at the same stop and have been enlarged by the same factor. Their different appearance is due only to the adoption of a different focusing position. These two images indicate how the size of the aberration patch and the distribution of light intensity within it vary according to focusing position. The lefthand image appears as a hard nucleus of good definition surrounded by plenty of aberration fringe of low intensity (not reproduced well in the engraving). In the righthand image the nucleus has been lost but the fringe occupies a smaller area. When residual zonal spherical aberration is small the image patches are small and the position of best focus is defined more precisely.

This variation of best focusing position illustrates the fact that poorly corrected lenses appear to have a greater depth of field compared with well corrected lenses yielding a higher standard of definition.

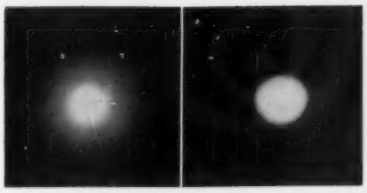


**Fig. 3. Effects of spherical aberration with same lens in different focusing positions.**

### Astigmatism

When the object and image points do not lie on the axis of the lens, the defects are more numerous and more complex. One of these is astigmatism and if it is the only aberration present, the object point will be imaged as two short straight lines occupying different positions in space; one line image being radial with respect to the lens axis and the other line image is at right angles to it. The diagram in Figure 4 is a three-dimensional drawing in which the ellipse represents the aperture of a lens. The axis of the lens meets a vertical and a horizontal line in the center of the focal plane. The diagram shows a bundle of rays passing through the lens and converging to these two line images. We call the radial line the sagittal image and the other line the tangential image. The distance between the lines is the measure of the astigmatism that is present and the position of best focus is midway between them. The image in this best focus position is of finite size compared with the ideal point image and its dimensions are proportional to the amount of astigmatism that is present. The diagram shows the conventional way in which the extent of this aberration is indicated. This shows the amount of aberration present in a narrow pencil of rays passing through the center of the iris diaphragm. The vertical scale represents the semi-angular field of view, measured in degrees from the axis of the lens, and indicates field covering power. The bottom of the vertical scale corresponds to an image position on the axis of the lens where this aberration must always be zero. The whole line shows the position of the radial image with respect to the focal plane at different angles, and the dotted line that of the tangential image. When the astigmatic errors are substantially zero at a point well out in the field, we say that the astigmatism is corrected and the residual errors at other angles are called zonal astigmatism. Performance away from the center of the picture depends on the size of these residuals. The errors increase very rapidly beyond the point where the positions of the radial and tangential images cross over one another, and it is for this reason that good performance can only be expected when the lens is being used for the angular field of view for which it was designed.

### Coma

Coma is another type of aberration which is restricted to off-axis image points and it shows itself as an asymmetrical aberration patch of some complexity. Figure 5 illustrates a relatively simple type of coma, in which the rays passing through the wider apertures of the lens cross the focal plane at positions which do not coincide with those where the narrower pencils of rays come to a focus. If, in such a case, the image were formed entirely by rays of light contained in the plane of the drawing, it would consist of a line of light AB. The cone of rays from each circular zone of the lens, however, comes to a focus in a circle rather than a point, consequently the image formed by the entire lens aperture is made up of a series of these comatic circles and the distribution of the light intensity is such that the aberration patch recorded in the photographic emulsion resembles the tail of a comet. Hence the name "coma." This important aberration must be considered in conjunction with the astigmatic correction and because of its complexity, no hard and fast rules can be laid down. The simple form of coma shown in the diagram is the exception rather than the rule in modern lenses, and the aberration is most difficult to correct in lenses having both wide aperture and wide field of view.

### Residual Aberrations

There is no great problem in correcting any one of these aberrations by itself, but the complete elimination of all three in lenses of useful apertures and useful fields of view is such a difficult matter that some appreciable residual errors are unavoidable.

As the number of lens components in any construction is increased, more variables become available to the designer and they are used to obtain a higher state of correction of image defects. Considerations of cost and bulk set a limit to the complexity that can be adopted

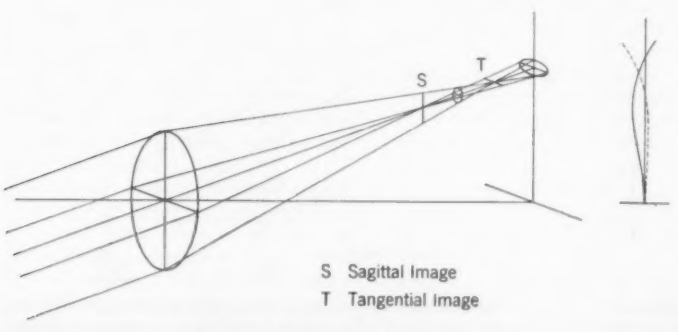



**Fig. 4. Diagrammatic illustration of astigmatism.**

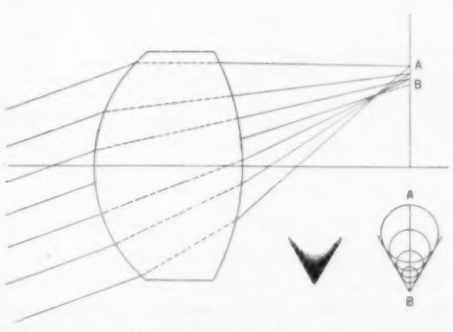



**Fig. 5. Illustration of "coma" aberration.**

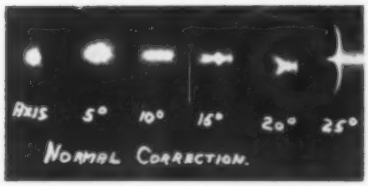



**Fig. 6. Image patches at various positions in the field of a typical modern lens.**

and there is little point in achieving remarkably good definition, if a large proportion of the light received by the lens is absorbed and scattered by a large number of thick lens elements. Some residual aberrations are thus inevitable and the complexity of construction is not increased beyond that required to reduce them to an acceptable level.

The fact that these aberrations are always present to varying extents means that instead of a point image of a point object we shall obtain an image patch of finite size, containing a complex distribution of light intensity. It is the shape and size of this image patch and the light intensity within it, which determines the performance of the lens. Figure 6 shows an enlargement of the image patches at a series of positions in the field of view of a typical modern lens of average complexity. The object at all positions was an illuminated pin hole at a very great distance from the lens, and the peculiar shapes at the wider angular field positions are due to the combined effects of astigmatism and coma.

The three aberrations are very loosely linked together in the sense that, if the complexity and general arrangement of a lens system remain unaltered, then the angular field can be increased at the expense of definition in the central and intermediate areas of the picture. This is illustrated in the next diagram, Figure 7, which shows the spherical aberration and astigmatism diagrams of two photographic lenses. These lenses are very similar in construction, having the same number and the same type of components, and both are designed for the same full aperture. It will be seen that one lens has a fairly high correction of spherical aberration and the astigmatism is not excessive over the field of view for which the lens was designed. Beyond this field the various aberrations increase very rapidly, and if useful images are required throughout this larger field, the other lens must be used. The diagrams for this second lens show how the corrections of zonal spherical aberration and zonal astigmatism are sacrificed in achieving the wider angular field.

### New Problems of Lens Design

The difficulties in obtaining wider angular fields of view whilst avoiding more complex constructions are not limited to the effects of the two aberrations shown in the diagram. Other aberrations tend to behave in a similar manner and further sacrifices of aberration correction are often unavoidable in providing reasonably uniform image brightness throughout a wider angular field of view.

This tendency towards a compromise balance between picture quality in the central areas of the negative and the useful angular field of view occurs in many types of lens and it should be clearly understood that best performance can only be expected when a lens is being used for the purpose for which it was designed.

The effects of the type of compromise which is often adopted are shown in Figure 8, which shows graphically the results of photographic resolution tests on two lenses of similar construction. Both have a relative aperture of $f/2$ and focal length of 50mm. Lens A is designed to cover the standard 35mm sound frame and lens B is designed to cover the VistaVision negative. Notice that lens A is incapable of covering all the

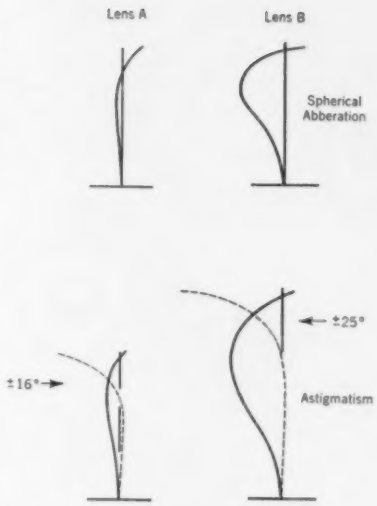



**Fig. 7. Diagram illustrating spherical and astigmatic aberrations of two photographic lens.**

VistaVision negative and that the wider coverage of lens B has been achieved by a small sacrifice of performance in the central regions of the negative. This sacrifice is, of course, small relative to the inherent advantages of reduction printing. The dotted curves corresponding to performance at a reduced object contrast equivalent to a density difference of 0.4 suggest that the sacrifice in the central performance is not very significant under normal working conditions. The differences in the center are reduced still further at reduced relative apertures.

The resolving power figures shown in the diagram indicate a difference between the performance of two lenses under identical test conditions. Resolving power is, of course, not the only criterion of lens performance, partly because the values obtained vary so considerably under different conditions of test and partly

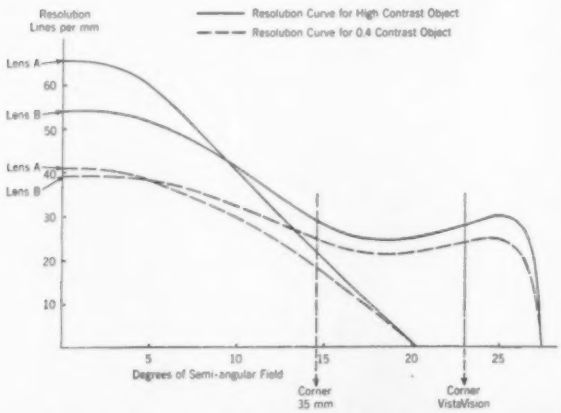



**Fig. 8. Resolution test on two lenses of similar construction; 50mm$f/2.0$ Lens A (normal 35mm), 50mm $f/2.0$ Lens B (Vista Vision).**

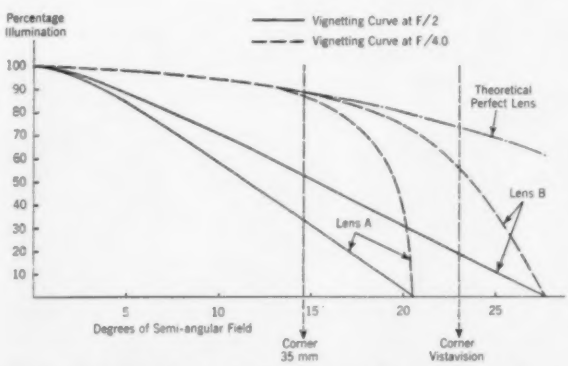



**Fig. 9. Difference in vignetting characteristics of normal 35mm lens and VistaVision lens; 50mm $f/2.0$ Lens A (normal 35mm), 50mm $f/2.0$ Lens B (VistaVision).**

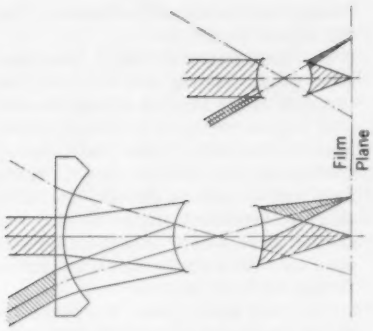



**Fig. 10. Reduction of vignetting by the use of inverted telephoto lens construction.**

because they relate only to the ability of a lens to record very fine detail. Other criteria are necessary to specify lens ability to record sharp definition at image boundaries but the tendency illustrated by this diagram will be present under all conditions.

There are also important differences between these two lenses in terms of the uniformity of illumination throughout the image. Figure 9 shows the difference between their vignetting characteristics. The curves plot percentage illumination at image points throughout the angular field assuming that illumination in the center of the field is 100%. Lens A is incapable of covering the VistaVision negative and the improved characteristic of lens B over its wider angular field, considered in conjunction with its improved resolving power in those regions as shown in the previous diagram, is an indication of the type of problem which has to be solved. The dotted curves indicate the effect of stopping down these two lenses to $f/4$ and it will be noticed that at $f/2$ and $f/4$ the illumination drops to zero at the same angular field.

Vignetting can be considered as a reduction in relative aperture for oblique beams of light so that the improved marginal definition at a higher light level together with the avoidance of additional complexity of construction represents a significant technical improvement.

The reduction of image illumination across the field of view is admittedly excessive in both lenses and it will be shown later how the adoption of wide-angle lenses of inverted telephoto construction can yield vignetting characteristics which approximate very closely to those of a fictitious perfect lens as indicated in this diagram.

A compromise between useful angular fields of view and picture quality is limited to small changes of covering power. A large increase in angular field of view, while maintaining a constant standard of performance, can only be obtained at a reduced relative aperture or by the adoption of more complex lens constructions. Since the film industry demands a constant standard of performance and wide relative aperture, the tendency towards the use of wider angular fields of view encourages the development of new and more complex lens forms.

Increased complexity of lens construction merely from the point of view of aberration control does not necessarily give an ideal solution since it can lead to a lens form which has undesirable vignetting characteristics. The top diagram in Figure 10 shows the external surfaces of a conventional wide-angle, wide-aperture lens. The diameters of these surfaces are set by the diameter of the axial beam at full aperture and, to some extent, the axial distance between these surfaces is set by the internal complexity of construction. The external lens diameters limit the width of the oblique beam proceeding to the corner of the negative and the relative widths of these beams, as shown in the diagram are a very rough indication of the variation in illumination across the negative. If vignetting were to be reduced in such a lens, it would have to be achieved by an increase of lens diameters beyond that required for the axial beam alone. This would most probably increase the magnitude of the oblique aberrations far beyond an acceptable level.

### Inverted Telephoto Lens

The bottom diagram in Figure 10 shows how some of these defects can be removed by the adoption of what is known as an inverted telephoto construction. An inverted telephoto lens comprises a front dispersive component, widely separated from a rear collective component. This provides a greatly increased back focal length between the rear of the lens and the focal plane. This means that the oblique rays proceeding to the corners of the negative pass through the lens at a greatly reduced angle. The vignetting will be reduced by very approximately the same factor, since it is, in general terms, proportional to this angle. The construction of the front dispersive component is one which does not produce any further vignetting. The two lenses shown in the diagram have the same focal length and the same relative aperture. The angular field in front of the lens is the same and the diagram shows how the amount of oblique light accepted by the lens has been increased.

In some cameras the space behind the lens is occupied by mechanisms which prevent the use of lenses whose rear surfaces are near to the focal plane. Some color cameras include a beam-splitting prism in this space and other cameras have reflex-mirror shutters. The inverted telephoto construction is most useful for these applications since the distance between the lens and its focal plane can exceed its focal length.

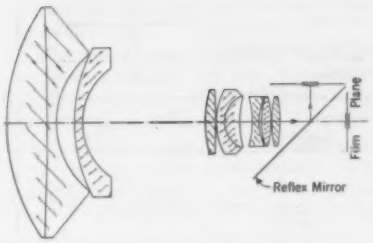



**Fig. 11. Camera reflex mirror shutter behind inverted telephoto lens; 18-mm $f/1.7$ for 35mm camera.**

Another useful feature of inverted telephoto lenses arises from the fact that the viewpoint of the lens is unusually far forward from the focal plane. On multi-lens turret cameras this feature permits the lens to accept a wide angular beam whilst avoiding obstruction from the front of other long focus lenses mounted on the turret.

Figure 11 shows a reflex mirror shutter behind a lens of this type and it also indicates the increased complexity of construction which is necessary should it be desirable to increase both the relative aperture and angular fields beyond those of cine camera lenses now in general use. A lens of this type can provide an adequate standard of performance for both definition and uniformity of illumination over a full angular field of 75° and at a relative aperture wider than $f/2$. Its complexity of construction emphasizes the great advantages to be gained from surface treatment or "blooming" and also the necessity of calibrating apertures in terms of T-stops. These two points will be discussed later.

The factors which call for increased lens complexity at the wide-angle end of the range apply in reverse to narrow-angle, long-focus lenses. Usually the relative apertures of lenses of long focal length are reduced in order to reduce weight and to allow the lens to be mounted within the mechanical limitations of the camera. The design problems are therefore simplified very considerably and high standards of performance are readily obtained with relatively simple lens forms.

### Problems of Lens Mounting

In considering the type of construction to be used for the longer focal length lenses on cine cameras, it is necessary to ensure that more than one lens can be mounted on a multi-lens turret camera. Lenses whose front surfaces are positioned at a considerable distance from the focal plane can obstruct the beam proceeding to other wider angle lenses on the turret and cause shadowing on the negative. 16mm film cameras are particularly limiting in this respect, as indicated in Figure 12. The turret is shown diagrammatically fitted with one 1-in.

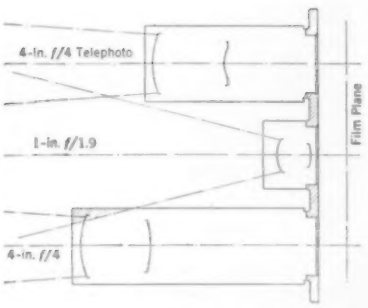



**Fig. 12. Diagram of 16mm camera turret fitted with various lenses.**

lens and two 4-in. lenses. One of the 4-in. lenses is of normal construction and its length from the focal plane is sufficient to obstruct the field of view of the 1-in. lens. The other 4-in. lens, which is a telephoto form, is essential for this application.

### Telephoto Lens

At the present time, the term "telephoto lens" is defined as a lens in which the distance between the front surface of the lens and the focal plane for infinity is less than the focal length. This leads to a more compact lens arrangement on the camera and the diagram shows how in some cases this compactness is essential, if one of the lenses on the camera turret is not to obstruct the field of view of another wider angle lens.

The telephoto feature is obtained when the lens comprises a front collective component widely spaced from a rear dispersive component. All aberrations can be well corrected if the two components each contain at least two lens elements. The telephoto feature tends to add to the complexity of construction if high standards of performance are required and Figure 13 shows the construction of a new *f*/4.0 telephoto lens which achieves the standard required for professional use on standard 35mm or larger negative areas.

### Surface Treatment of Lens

Many of the lens constructions now in general use and being developed could not exist at all but for the advantages to be gained from surface treatment or "blooming" to reduce light reflection at their polished glass surfaces. If the surfaces of complex lenses were not coated, so much light would be reflected back and forth among the surfaces that an appreciable amount would reach the

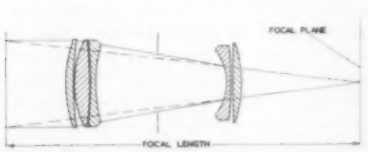



**Fig. 13. Diagram showing construction of new *f*/4.0 telephoto lens.**

focal plane as a diffuse haze which reduced contrast. In some cases the focusing point of light which has been reflected by two or more surfaces in the lens falls very near the focal plane and "ghost" images appear on the negative when a brilliant source of light is near the field of view.

The reasons for this state of affairs are shown in Figure 14. The graph plots the variation of reflection and transmission of a single glass surface against the refractive index of the glass from which the lens component is made. Curve A refers to polished surfaces which have not been coated. Notice how the reflection factor increases with refractive index. Before the war, many photographic lenses utilized refractive indices averaging about 1.57, and uncoated glass-to-air surfaces at this index reflect about 5% of the light incident upon them and transmit 95%. If we ignore the absorption of light within the body of the glass a lens containing eight of these surfaces would transmit 66% of the light available and over 30% is reflected and scattered. If improved correction of optical aberrations is achieved by the use of modern high-index glasses, the transmission of this form of lens is reduced to about 57% and the amount of light which is potentially capable of reducing contrast and forming "ghost" images, exceeds 40%. In the absence of coating therefore, optical improvements due to the use of glass of higher refractive index can only be obtained at the expense of contrast.

In the last few years the technique of coating lens surfaces to reduce reflection has been brought to a high degree of perfection. If the polished surface is coated with a very thin film of transparent material having a thickness of about 4 millionths of an inch and a predetermined refractive index, the reflection factors are reduced to the values shown by curve B. If our first example is coated in this way, the reflection is reduced from over 30% to about 10% and the reflection of our second example is reduced from over 40% to about 4%. The coating therefore provides better contrast characteristics when use is made of the new high-index glasses.

White light is made up of several colors and the reflectivity of a single-layer coating can only be a minimum for one color of the incident light. The reflection for other colors is somewhat greater and this variation accounts for the so-called "bloomed" appearance of coated lens surfaces. Lenses treated for minimum reflection and maximum transmission at the center of the visible spectrum will reflect slightly more light at the ends of the spectrum in the red and the blue, and thus the reflected light will be purple. Coatings for special purposes will have different appearances. Lenses intended for use at the blue end of the spectrum will appear to have a straw or reddish coating and for the red end the coating will appear bluish.

The advantages of surface treatment were proved during the war and the demands of the Services greatly accelerated improvements in technique, which have resulted today in the production of coatings of high efficiency which are as hard and durable as the glass on which they are deposited. In some cases the coating also serves to protect the surfaces from tarnishing under humid conditions during the life of the lens.

The fact that surface treatment increases the amount of useful light that the lens can transmit to its focal plane may be considered merely as an incidental advantage. Coating would be well worth while for the reduction of reflection alone.

It might be thought that surface treatment would bring the transmission of all lenses of the same aperture to a common level irrespective of the type of lens construction. This is not the case; partly because it is not always possible to use high refractive indices for all the elements in a lens, partly because the coating is never 100% efficient over the wide range of colors to which panchromatic emulsion is sensitive and partly because many types of optical glass have a poor transparency and absorb appreciable amounts of light.

### Exposure and Processing Control

In recent years there has been a demand for more exact control of exposure and processing than hitherto, and this has underlined the variations in transmission between different lenses of the same nominal *f*-number. Variations as wide as half a stop have been noticed between coated and uncoated lenses of the same type and similar variations exist between coated lenses of widely different construction.

It has been suggested that these differences should be compensated for by calibrating the iris diaphragm in T-numbers instead of *f*-numbers. This procedure has been adopted generally by the American film studios and the demand in this country is increasing rapidly.

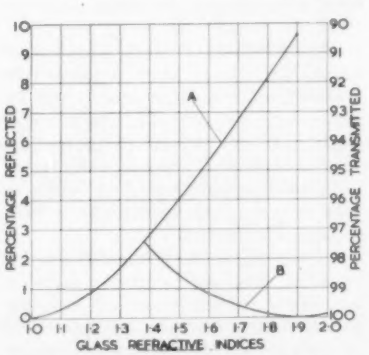



**Fig. 14. Percentages of incident light reflected and transmitted from a transparent surface at normal incidence.**

T-number is defined as being the *f*-number of a lens which is completely free from all reflection and absorption losses. Thus a T/2 lens transmits as much light as a fictitious *f*/2 lens with 100% transmission.

A Speed Panchro type of lens with eight glass-to-air coated surfaces and the usual thickness of glass may have a transmission of about 85%. If this lens is to have an aperture of T/2, its true relative aperture must be *f*/1.85.

The inverted telephoto wide-angle lens shown in an earlier diagram is even more complex and to achieve a T-stop of T/2, its relative aperture must be increased to about *f*/1.7.

It has been argued that the change to T-stops will prevent accurate calculation of depth of focus. Depth is determined by the angle of the cone of light converging from the lens opening to the axial image point and admittedly the angle will be slightly larger at T/2 than at *f*/2. The effect on performance due to calculations based on T-numbers instead of true *f*-numbers is not likely to be very serious, however. The error will show as an increase in the size of the actual disk of confusion over that allowed for in the depth calculations and the difference is constant at all distances and all apertures. In the case of the T/2 lens whose true *f*-number is 1.85, the increase only amounts to about 7½%.

The transmission of a lens, and hence the accuracy of T-stop calibration, is impaired by dirty lens surfaces and it is not always realized that the quality of the picture, for definition and contrast, is dependent to a significant extent upon the cleanliness of the lens and its freedom from scratches.

The use of larger negative areas is not necessarily limited to the VistaVision process. Current trends indicate that their inherent advantages can be usefully employed in other systems, including those which utilize anamorphotic compression and subsequent expansion in the theater. The existence of suitable means for anamorphotic printing from a straightforward large negative makes it possible to avoid the optical and mechanical disadvantages associated with the use of anamorphotic attachments on a camera. Large negatives which can be processed in a variety of forms are more valuable than those having a limited application and their advantages should improve the quality of any type of print derived from them.

# A Film Age for Education

By PHILIP A. JACOBSEN
*Illustrated by* NILS STROM

*The rise of the theatrical motion picture from a slot machine to one of the world's great arts was watched by a hopeful group of educators with feelings of delight, then dismay and finally frustration. They, of course, were delighted with the film's educational possibilities but dismayed by the endless parade of tawdry pictures and, in the end, frustrated, because, while believing Bernard Shaw's* "Fine art is the only teacher, except torture," *they failed to induce education to embrace the fine art of the film.*

In time, less visionary schoolmen accepted an emasculated thing they called "an audio-visual aid," which the teaching profession as a whole has never taken very seriously. Television may prove Thomas Edison right, but his early prediction that students would soon be required to watch a screen three hours a day disturbed no one. Unfortunately, the advocates of "A Film Age for Education" have little to show that is good enough to impress the comfortably settled defenders of established practices. Furthermore, the mechanics of showing classroom pictures is fantastic enough to kill all enthusiasm. The routine goes something like this:

1. Enroll in an accredited college course in audio-visual aids. Learn the psychology of teaching with things students can hear and see, as differentiated from those that are silent and invisible.

2. Study an educational film catalog. Most such catalogs list every Hollywood boxoffice flop. Disregard these. Search for duller stuff. Select only reels classified under the subject you are teaching. It is often difficult to determine the classification from watching the screen.

3. Write for the film. Give second, third, fourth and fifth choice. State four or five dates when the film can be shown without interfering with class progress.

4. Upon receipt of film, inspect carefully. Replace chewed up leader. Check for broken sprocket holes. Sponge with carbon tetrachloride. Find sound start.

5. Prepare introduction to be read before screening and an apology to be read after screening. Accepted technique is to tell students what they are about to see before showing the film and give them a digest of what they have seen, after projecting film. A skilled narrator may omit the film.

6. Find a projector that is rumored to be in good repair. Mount half way back in the center aisle on a broken down table. Run power cord to a convenient outlet in the janitor's slop-closet — at least 100 ft down the hallway. Find distributing panel. Put pennies under fuses.

7. Set up screen at front of room if possible. Keep in mind that the folding screen tripod was invented by a bear-trap designer. Considerable practice is required to set up the trap without throwing the class into an uproar.

8. With help of janitor, stepladder and pole, close blackout curtains. Close windows to prevent curtains from being sucked out. Hall door may be left open to prevent suffocation.

9. Find switch. Curtains always leak sufficient light to enable the projectionist to find the projector.

10. Turn on projector. During titles and opening footage, elevate front of machine on thin textbook. Frame picture. Adjust volume. Adjust tone. Re-orient speaker. Focus lens. Turn out threading light.

11. *Special note:* If film breaks during showing, turn on threading light, make tuck-in splice, cover with reassuring remarks. Finish projection. Disregard snide dialogue by precocious kids.

12. Turn off projector as tail of leader clears gate.

13. Find light switch.

14. Cut down blackout curtains.

15. Fold bear trap.

16. Read apology.

17. Summarize film content — if any.

18. Wake and dismiss class.

19. Secure power and speaker cables.

20. Return screen and projector.

21. Return film with letter of condemnation.

22. Under protest, O. K. voucher for film rental.

23. Abandon audio-visual aids to the birds with incurable film fevers.

Naturally the negative reaction to education by way of films, together with all the intricate obstacles cluttering the path to maturity, caused the educational film to suffer an arrested development.

Today's educators have less reason to be frustrated. The film has ascended to a superb theater, an invaluable laboratory tool, a salesman's right hand, ideal television fodder and a means of documenting anything from cute kid capers to fast moving global warfare. Today these advances, together with education's desperate need for mass production tools, give greater hope for the transition from an audio-visual aid to an automatic teacher.

During the past fifty years as the motion picture grew from a risky novelty to a gilt edged security, the population of the United States grew and doubled until by 1954 the yearly harvest of little TV and Box Office futures was a whopping 4,060,000. This "Show of New Faces" was the "best picture of the year" to the movie industry. To the harassed schoolman, however, the king-size "blessed event" was about as welcome as triplets to a forty-a-week doorman already supporting five kids.

A great many Americans who believe in free schools take "free" so literally that they consider school taxes almost illegal and vote against all new appropriations. Ironically these same rugged pinchpenny advocates of cut-rate education buy killing quantities of lush food, oceans of booze, mountains of cigarettes, pack endless highways bumper to bumper with expensive cars, sport the world's finest garments and clutter their houses with all manner of costly gadgets. Americans will gladly goldplate a factory production line to meet competition or

Presented in April 19, 1955, at the Society's Convention at Chicago, by Richard C. Polister who read the paper for the author, Philip A. Jacobsen, Technical & Research Director, Campus Studios, 117 Meany Hall, University of Washington, Seattle 5.
(This paper was received on April 19, 1955.)

*"Free" schools*

to get one-tenth of one per cent additional profit, but react to cries for help by building a few cheap schools and acting as though their autos, TV sets and refrigerators were being simultaneously repossessed by the sheriff. A strange way to treat our children — strange and weirdly inconsistent with almost everything else we do to survive and like it. What big industry, for example, would expect to compete at home and abroad short thousands of square feet of floor space and urgently in need of tens of thousands of workers, plus being millions behind in its building program and denied up-to-date tools, engineers, scientists, lobbies, protective legislation, advertising and enthusiastic buyers. Yet today's schools, short 300,000 classrooms and 175,000 teachers, are expected to develop a product on which we can safely stake our very lives.

Estimates indicate that in the next fifteen years as much floor space will have to be provided for higher education alone as was built for colleges in the last three hundred years. Even worse, by 1970 higher education will probably need half a million new teachers unless some revolutionary new devices and techniques materialize. Obviously the time has come to declare that "educational opportunity for everyone" is nonsense *or* put a good, modern footing under the idea.

**Film as an Educational Tool**

It is traditional to classify pictures as theatrical and nontheatrical but this is quite arbitrary and may be misleading. The question is "Should educational films be theatrical?" The answer is "Yes. Whenever the subject lends itself to theatrical treatment, dramatize it." If hamming up even a nuts-and-bolts job makes an instructional film better, then ham it. Run-of-the-mill teachers, using conventional classroom methods, have never stimulated interest enough to trigger effort and promote learning as well as have those rare teachers who can put on a good show.

Unfortunately there have never been very many good teachers and it doesn't seem likely that there ever will be so many that students can count on heavy bookings of live talent or daily personal contacts. Even if there is enough cash to hire all the talented live performers that schoolmen may want, they may be engaged in other vital social and economic activities, and available only for occasional appearances. It is also unlikely that in the foreseeable future education will get a much bigger per cent of the tax take than it is now getting. Short of emptying the public purse at the point of a gun, then, the only thing left for schoolmen to try is mass production techniques and tools, the most promising being the recording, the motion picture and television.

The modern motion picture is a marvelous mosaic of perfected parts, creatively associated in an adjustable time frame to reproduce an endless variety of meaningful stories. It embraces all art, all language and all science in a unique form of its own. It mimes life so perfectly that many imaginative individuals find it difficult to keep the line between film and fact in sharp focus. It creates entirely new worlds, composite people and imaginary situations almost as easily as it records real life. How can education ignore such a perfect medium for its purposes?

There is no doubt that, in some situations, the film is a poor substitute for a live teacher, but certainly a teacher is no substitute for a film when it comes to presenting properly a great variety of subjects. Students, of course, should not miss opportunities for personal contact with inspiring teachers, but just how many such people can education count on getting? In any situation, however, recorded and filmed lessons will free the teacher from putting in endless time as a talking machine, a demonstration barker and a five-a-day classroom plugger. Note that some of the time liberated by robots could be used for personal contact with students, thus increasing instead of decreasing time available for flesh and blood communion. Note too that teachers who normally prepare only one set of lectures in a life time and then spend the rest of their days impersonating a machine, might find time to develop a second, or maybe even a third set of lectures, lessons or demonstrations.

Note finally that in the hands of the photoplay manufacturers, the film for years actually molded minds, while educators did practically nothing to develop the educational film. Instead, resting on their ancient home grown laurels, many of them damned Hollywood for ruining the legitimate theater, inventing and teaching sinful new patterns of behavior and spreading discontent with everything from cotton stockings, the handlebar mustache and the kitchen stove, to male supremacy, the United States Constitution and God. Undoubtedly, most of today's savants regret the offish, ivory-tower stance assumed by yesterday's schoolmen and are now convinced that the motion picture, along with the pen, may some day be mightier than the atom.

How can education justify the high cost of anything but an occasional film to relieve students and teachers from boring each other? In the first place, of course, some school work cannot advantageously be presented with motion pictures. Don't try. A great many subjects, however, may cost less per person to communicate through pictures or recordings than through any other medium. (Incidentally, a recording is a soundtrack which stimulates its own picture as it goes — a sort of low cost inside job.)

Practically all educational pictures can be low cost by Hollywood standards. For example, take a lesson in surgery.

Two or three interns stand close enough to the operating table to make out what the surgeon is doing. A dozen or more students sit in a gallery where they can see nothing. Their turn may or may not come to see when and if another similar case is found. Obviously, the business of training surgeons two or three at a time is long and costly, but if the operation had been photographed, every doctor and student in the country could see every detail in color on a big screen and see it over and over again and at a very, very reasonable figure. To illustrate the point, let's say this film cost five thousand dollars to make and distribute. Let's say, and these are conservative estimates, that during the life of the film ten thousand medical men see it. That makes the unit cost fifty cents, and what can fifty cents buy in the way of text material, lectures or three-at-a-time demonstrations?

Take another example: One hundred schools, each with auditoriums seating one thousand, project a film costing ten thousand dollars to make. If it is used

thus, twice each year, for five years and then scrapped, what will be the production cost per pupil? Answer, one cent. Theatrical picture men, of course, are born knowing such things — they can teach schoolmen in a few lessons.

What do educators need in the way of equipment to turn out good movies? What did Porter have when he shot

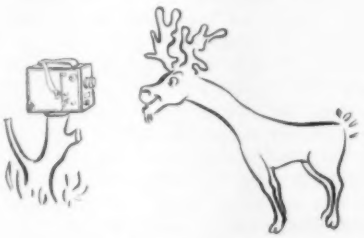
*The Great Train Robbery*? How many tons of gear did Flaherty carry around while making *Nanook of the North* or *Louisiana Story*? What did Herb Crisler have but an old Cine and a couple of lenses when he shot footage which Disney bought for *Olympic Elk*? How much fancy gear did Grierson sport when he did *Drifters* or Lorentz when he made *The Plow That Broke the Plains*? What was *The Cabinet of Dr. Caligari* but a good story and a clever, low-cost paint job? What did Eisenstein have but a relatively new idea in editing and a clever pair of shears? These, and innumerable other successes, together with all the acknowledged high-priced failures, suggest that there may be a negative correlation between cost and quality.

The more fancy gear, the more gigantic sets, the more costly direction, the more name stars, extras, musicians, process work and ballyhoo, the less screen time there seems to be for portraying real human relationships, dealing with fundamental problems and developing the arts. Even a positive coefficient of correlation between cost of production and boxoffice take is more of a hope than a certainty. Further, many educators who fully appreciate an inexpensive job like *The Little Kidnappers* but do not enjoy costly De-Milloramas or Sexamusicals find it easy to believe in the negative correlation hypothesis. They should not be hard to convince that educational movie makers not only don't need a pile of costly equipment but might be better off without it.

To an educational motion-picture man, a giant crane, mounted on a track laid down as it goes into a set which is taken apart as the camera enters, is a fantastically expensive device for making lap dissolves. Also, to the operator of an educational studio, a twelve-input re-recording channel, interlocking everything from film loops to Coca Cola machines, is about as appropriate for a school studio as a tie-in with an Astronomical Observatory would be for a housewife trying to time a couple of eggs.

**What Engineers Can Do**

What can engineers do for education and in so doing help themselves? To begin with, the Education Department of the United States Chamber of Commerce says: "To maintain a free society, and to keep America's economy dynamic, educational levels must be steadily raised. When you take an active interest in providing better educational opportunities in your community, you make a real contribution toward Good Citizenship, Good Government and Good Business." In the language of the Society's Dollars and Sense Department, "Good Business" should be what we have when education brings greater earning power and higher standards of living with more money for the finer things of life, such as good movies.



Obviously, to make more pictures is the goal of both commerce and education. There undoubtedly will be more pictures. In fact, good educational pictures for release in classrooms, on television, in churches, in clubs, to civic and business organizations and to individuals may some day rival the demand for all other types of film. In case this actually happens, it stands to reason, there will be a great many more jobs for motion-picture and television engineers. Of course, those jobs will not be just like jobs in the entertainment business. Most of the pictures for education should be made primarily to do better and more cheaply the work education is now doing poorly or not at all. Many of these pictures may be made in studios specially designed and engineered for educational purposes. The Society's new Committee on Education will probably want to formulate standards and specifications for engineers who look forward to entering the field of education.

Right now engineers can clean up the kind of nightmare students and teachers often go through to screen a picture in a classroom. (The description given earlier is too near the literal truth to be called burlesque.) With push-button operation of everything from doorbells to guided missiles, engineers will not need to do extensive research before designing the monkey business out of projecting films in the schools.

Schools will need studios and theaters and lots of them, widely distributed throughout all varieties of institutions. These facilities, of course, must be carefully designed by qualified engineers and architects to meet the unique requirements of educational picture making and utilization.

There is practically nothing in conventional Hollywood studios that can be profitably incorporated, without modification, in educational studios. Educational film makers need wholly functional equipment which will reduce the mechanical problems of production to simple ones, easily handled by school personnel. After all, the mechanics of picture making are no longer a mystery or a work that must be restricted by complicated and difficult operations to a group of devilishly clever initiates. The number of good films made by the vanguard of the Film Age for Education is proof enough. Engineers can solve the equipment problem.

The great motion-picture industry would probably never have achieved its position as a strong, stable business if it had not been that producers controlled release. There must be some organization to guarantee that films reach a profitable screen. This is another one of the things established film producers were born knowing but something vital to the development of an Educational Film Age which schoolmen must learn. Sooner or later, to succeed with films in a big way educators must set up a nationwide cooperative for financing and distributing educational films. They will need help from experienced motion-picture men to do it.

Our president, Dr. Frayne, has "proposed the formation of a Committee on Education to study, among other things, the motion-picture industry's long-term need for trained engineers, its ability to absorb them and the kind of specialized engineering manpower that healthy progress demands be made available." It is hoped that this may be interpreted to mean that the Committee will be interested, among other things, in:

1. Adding a discussion of "A Film Age for Education" to its agenda for the coming year.

2. Helping formulate comprehensive plans for developing and exploiting the relatively unexplored field of education by transcription, film and television.

3. Developing engineers who are not just specialists in the design and operation of motion-picture and television machinery but men big enough and broad enough to make certain that the recording, the film and television are used, not only to sell merchandise and kill time but to bring pleasure and greater understanding to everyone.

# news and reports

## 79th Convention • • • New York • • • April 29 – May 4

This convention promises as extensive, interesting and informative a program of technical papers as has been had in many years. Supplementing the nineteen sessions of formal presentation, and of parallel scope and value, will be the exhibit of professional motion-picture and television equipment. The displays will offer for close scrutiny, the most modern production tools of the film and TV trade. And all of this comes at the time of year when New York is at its most attractive, and its weather leaves little to be desired.

The Advance Notice of the Convention, which went out to members in mid-March, contained a rate and reservation postcard for return to the Hotel Statler. The Statler is convention headquarters, and most sessions will be held there, across Seventh Avenue from Penn Station. Sessions held elsewhere will be only a short subway or taxi ride away.

Also in the Advance Notice was a member's registration card and order form for luncheon and banquet tickets. A welcome innovation is the ten percent discount to members who buy the entire package — registration, luncheon and banquet tickets — in advance. And there is also a ten percent discount to members on the purchase of ten or more banquet tickets. Ten is one full table.

Refunds on unused luncheon and banquet tickets can be given only if returns are made prior to the starting time of the meal.

### EVENTS

The Get-Together Luncheon will be held on Monday at 12:45. Dr. Frayne will preside and will introduce the luncheon speaker, Dr. A. W. Trueman, Canadian Government film commissioner and head of the National Film Board of Canada. Dr. Trueman will discuss the work done by the Film Board and will cite the significance of the techniques which they have employed to the motion-picture medium.

The customary formal cocktail party and banquet, the prime social event of the convention, will take place on Thursday evening. Music will be supplied by Howard Lanin's orchestra.

### EXHIBITS

All convention registrants are welcome to visit the equipment exhibit in the Penn Top area of the Statler. It will feature more than 32 booths displaying film-processing and editing machines, motion-picture and high-speed cameras, lenses, sound and animation equipment, and TV color cameras and projectors. A list of exhibitors appeared in the February *Journal*.

### ARRANGERS

Responsible for completing all the arrangements, so essential to a smoothly run convention, are the following committee chairmen appointed by Byron Roudabush, Convention Vice-President.

*Local Arrangements*

*Chairman*, George H. Gordon

*Exhibits*, Everett Miller, Assisted by Victor M. Salter

*Hotel Arrangements*, Saul Jeffee, Assisted by Frank S. Berman

*Public Address & Recording*, Edward Schmidt

*Registration*, Kern Moyse

*Luncheon*, Frank Marx

*Hospitality*, Charles Seager

*Transportation*, William J. Reddick

*Banquet*, M. Clay Adams

*Projection*, Harry DeFuria

*Membership*, Joseph T. Dougherty

*Publicity*, Sue Grotta

*Ladies*, John B. McCullough

*Hostesses:* Mrs. George H. Gordon and Mrs. Everett Miller

*Administrative Assistant*, Harold J. Jones, Jr.

The following programs already show accomplishments for many of the convention committeemen.—*S.G.*

### LADIES PROGRAM

*Sunday, April 29*

*2:00 P.M.:* Registration, Penn Top, 18th Floor, Statler. Ladies headquarters: Hudson Room, Mezzanine.

*Monday, April 30*

*9:00 A.M.:* Registration, Penn Top, 18th

*12:45 P.M.:* Get-Together Luncheon

*2:00 P.M.:* TV shows, local theaters, etc.

### TENTATIVE SCHEDULE OF COMMITTEE MEETINGS

*Monday, April 30*

10:00 A.M. Screen Brightness
2:30 P.M. Film-Projection Practice

*Tuesday, May 1*

10:00 A.M. Association of Cinema Laboratories
2:00 P.M. Laboratory Practice
3:30 P.M. Film Dimensions

*Wednesday, May 2*

10:00 A.M. *Open Forum to review picture-sound separation of 16mm magnetic sound film*
10:00 A.M. Papers Committee/Board of Editors
2:00 P.M. Magnetic Recording Subcommittee
3:30 P.M. Sound
5:30 P.M. Section Chairmen

*Thursday, May 3*

10:00 A.M. 16 & 8mm
2:00 P.M. Television

*Friday, May 4*

2:00 P.M. High-Speed Photography

*Final schedule of meetings will appear in the Convention Program. Meetings notices will be mailed to all Engineering Committee members.*

*Tuesday, May 1*

*9:00 A.M. to 12:30 P.M.: Oklahoma* (included in registration)

*1:00 P.M.:* Luncheon at Sardi's, Dutch Treat, $3.50 to $5.00 per person; cocktail, luncheon, tip complete

*3:00 P.M.:* Metropolitan Museum of Art, guided tour of the American Wing (included in registration)

*Wednesday, May 2*

*11:30 A.M.:* Fashion Show and Luncheon, Waldorf Astoria Hotel (included in registration)

*7:00 P.M.:* Underwater Television Papers, Skytop, Statler

*Thursday, May 3*

*10:00 A.M.:* Tour of Lever Bros. Park Avenue Headquarters. Visit to their

### MAKE HOTEL RESERVATIONS AND REGISTER AT ONCE

There will be another convention at the Statler at the same time as the SMPTE meeting. To assure space, make your room reservations directly with the hotel *at once*. If you wish to take advantage of the ten percent discount available to members who register by mail in advance *and* purchase a luncheon and banquet ticket, send your advance registration form to headquarters immediately.

world-acclaimed executive offices, working floors, dining rooms and lounges and inspection of their famed test kitchens (included in registration)

*Afternoon:* Free

*6:45 P.M. to 8:00 P.M.:* Cocktail Party, Statler

*8:00 P.M. to 1:00 A.M.:* Banquet and Dance, Statler

*Friday, May 4*

Farewell Get-Together Punch Party, Ladies Headquarters—Hudson Room, Mezzanine (included in registration)

Motion-picture theater privileges will be available through convention badges. TV show admissions and special rate tickets to Rockefeller Center, Empire State Building and the famous Circle Line Tour by boat around Manhattan will be available to those registering.

### PAPERS PROGRAM PRODUCERS

Under the Papers Committee Chairman Ralph E. Lovell, the standing roster of Vice-Chairmen is: J. E. Aiken, G. G. Graham, C. E. Heppberger, B. D. Plakun, Petro Vlahos and J. H. Waddell.

The local Vice-Chairman automatically ticketed for the forthcoming New York Convention thus was Ben Plakun — officially 79th Program Chairman. In this capacity, Ben Plakun extended the recent system of special chairmen for symposiums a final step and set up his entire activity by topics. These are the Topic Chairmen who produced the Advance Program:

Laboratory Practice — *W. H. Rivers*
Motion-Picture Equipment — *Willy Borberg*
TV Studio Lighting — *H. M. Gurin*
Underwater Television—*Herbert Barnett*
High-Speed Photography — *J. H. Waddell*
Sound Recording — *George Lewin*
TV Film Commercials — *W. J. Morris*
Television — *S. W. Athey*
Motion-Picture Short Films — *E. M. Stifle*

Past Program Chairman *Glenn E. Matthews* contributed much to the early organizing of this Program as well as adding to its momentum up to completion.

### SESSION OPENERS

Chairman E. M. Stifle has arranged for the following motion-picture short subjects, all in 35mm color with optical sound, as opening fare for technical sessions:

*Tulip Time in Holland*
*Italian Memories*
Warner Brothers Pictures Corp.

*Magoo Goes West* (cartoon)
*Magoo's Sick Friend* (cartoon)
Columbia Pictures Corp.

*Stunt Pilot* (CinemaScope)
*Land of the Bible* (CinemaScope)
20th Century-Fox Film Corp.

*Bing Presents Oreste* (VistaVision)
*VistaVision Presents Sun Trails* (VistaVision) Paramount Pictures Corp.

*Two of the latest color cartoon shorts*
Loew's Inc.

# ADVANCE PROGRAM

**The sessions of the Convention are almost certain to be held as outlined below *but a few papers may be moved, curtailed or deleted* because of the fullness of some sessions; therefore, if you are interested most especially in a very few specific papers, you should inquire a week before the Convention by telephoning either to Bernard D. Plakun, General Precision Laboratory, Pleasantville, N.Y. (Pleasantville 2-4100), or to Society headquarters (Longacre 5-0172).**

## *SUNDAY — APRIL 29*

**Registration will open at 2:00 P.M. in the Statler's Penn Top Foyer and Ladies Headquarters will open at the same time in the Hudson Room on the Mezzanine.**

## *MONDAY — APRIL 30*

**9:00 A.M. Convention Registration**
**9:15 A.M. Opening Remarks John G. Frayne, SMPTE President**
**9:30 A.M. Laboratory Practice Session I**

**Stainless Steel Bearings for Film Processing Machines**

LEONARD F. GIARRAPUTO, Pathe Labs Inc., New York.

Bearings for high-speed motion-picture film processing machines have always presented rather unique engineering problems. These problems are harder to overcome with color-film processing solutions which have higher corrosive properties. Extended tests on a variety of bearing types led to the development of a two-piece, deep-groove ball bearing with a number 316 (18-8) stainless-steel retainer that has low friction and excellent life characteristics when operated in either black-and-white or color-film processing solutions.

**Plastics in a Motion-Picture Processing Machine**

JOHN W. RAYMOND, Airlab, Phoenix, Ariz.

Many plastics provide excellent chemical resistance and ease of fabrication. Their flexibility, low joint strength and heat distortion require special consideration in machine design. Utilizing hot impinged air drying and compactness, AirLab has built a 16mm, black-and-white, negative-positive machine using Uscolite, Epon, Tygon, Nylon, and Neoprene to make racks, elevators, piping, special valves, sheaves and tank linings simply and at low cost. Results indicate the suitability of some of these materials in a color machine.

**Processing Methods for Use With Two New B&W Reversal Films**

C. E. IVES, J. W. ZUIDEMA, N. A. EXLEY and C. C. WILT, Eastman Kodak Co., Rochester, N.Y.

Two new 16mm black-and-white reversal films have been introduced to satisfy the present-day requirements for extended speed range, improved picture quality and ease of processing in rapidly working baths at normal and elevated temperatures. A study has been made of the reversal process with reference to the needs of these films when handled on various types of continuous and batch equipment of practical interest. Recommendations are made for processing bath composition and replenishing practice for obtaining highest quality and consistent results.

**A Machine for Cleaning Motion-Picture Film**

JOHN R. TURNER, STANLEY L. SCUDDER and EDWARD H. DEANE, Eastman Kodak Co., Rochester, N.Y.

An experimental machine is described for the cleaning of motion-picture film. The successive stages in the machine include spray application of detergent solution, spray rinsing, pneumatic squeegee and impingement drying. This entire sequence of operations requires about 12 sec. The machine is also useful for the removal of alkali-soluble lacquer coatings.

**12:30 P.M. GET-TOGETHER LUNCHEON**
**A. W. TRUEMAN, Canadian Film Commissioner.**

**A CONCURRENT SESSION**
**2:00 P.M. Laboratory Practice Session II**

**Splicing of Motion-Picture, Polyester Film Base and Standard Acetate Safety Film Base by the Butt-Weld Method**

LEONARD A. HERZIG, Prestoseal Manufacturing Corp., Long Island City, N.Y.

This paper describes an improved method and apparatus for butt welding and butt splicing of polyester film base and standard triacetate film base. The principle is a combination of a controlled heat and cooling gradient applied under pressure within a given time cycle. Both the method and apparatus for butt welding for similar type bases and a method of butt splicing by the use of an additional high temperature transparent adhesive sliver are described. The combination of both methods used simultaneously is also discussed.

**Spray Processing in a Commercial Laboratory**

RALPH D. WHITMORE, JR., Du Art Film Laboratories, New York.

The design of a spray processor, four of which are now in full operation, using impingement drying, was based on both experimental data of the last two decades and operational experience gathered during the last two years. These are used for developing 16mm and 35mm black-and-white negatives and positives of all types at 80 F. The great versatility of the units, along with accurate sensitometry and chemistry, has increased both quality and volume in the laboratory.

**Scene-Change Cuing in Motion-Picture Printing**

ROBERT C. LOVICK, J. MARVIN SEEMANN and JOHN G. STOTT, Eastman Kodak Co., Rochester, N.Y.

Some of the methods for scene-change cuing used in professional motion-picture printing are presented. Advantages and difficulties inherent in the various techniques are discussed. Methods are described for improving electrical scene-change cuing by using a split roller switch, aluminum adhesive tape patches, a modified Ripley electronic relay, and a magnetic recording time-delay device. The accuracy of the edge notch and electrical scene-change cuing systems is demonstrated.

**Improving Contact Motion-Picture Printers Through the Use of Internally Directed Air**

HOWARD F. OTT and ROBERT C. LOVICK, Eastman Kodak Co., Rochester, N.Y.

Adequate contact in printers is generally obtained through the use of close-fitting pressure shoes, roller gates, or by air applied to the base of the raw stock. A method of directing the air on the base of the negative is described. The advantages are discussed.

**Increasing the Washing Rate of Motion-Picture Films With Salt Solutions**

R. W. HENN and J. I. CRABTREE, Eastman Kodak Co., Rochester, N.Y.

Adsorbed thiosulfates may be effectively eliminated from films by the use of salt solutions. The salts may be employed in the wash water, as when washing with sea water, or as a separate bath previous to washing. The rate of elimination is largely controlled by the anion, and monovalent anions such as acetate and chloride are less effective than polyvalent anions such as sulfate, sulfite, phosphate and citrate. These principles are incorporated in the Kodak Hypo Clearing Agent. The effectiveness of this bath is most striking with films fixed in strongly hardening alum fixing baths and washed in cold water. Under these conditions it is not unusual to have the hypo reduced to 1% of that left by washing alone for equal periods. The results obtained when this product is applied to machine processing of motion-picture and microfilm films are described. In general, savings are effected in both the time required and the water consumed, while very low levels of residual hypo are attained.

## *MONDAY AFTERNOON*
## A CONCURRENT SESSION
## Television Studio Lighting Session I

## 2:45 P.M. Television Studio Lighting Session I

**Light Sources for the TV Studio**

GEORGE T. HOWARD, General Electric Co., Cleveland.

Many factors should influence the selection of a light source for TV studio lighting. The characteristics of existing sources are reviewed with emphasis on features that determine their acceptability or unacceptability.

**Carbon Arcs for TV Studio Lighting**

R. B. DULL and J. G. KEMP, National Carbon Co., Fostoria, Ohio.

The performance of typical carbon arcs suitable for TV studio lighting, particularly for special effects on stage and for process projection in both black-and-white and color TV, are described. Color modified carbons, the light from which can be mixed with that from other types of light sources, with little or no filtering, are emphasized.

**Color Television Lighting Control**

ROBERT W. BYLOFF, National Broadcasting Co., New York.

This paper first traces the evolution of the presently used lighting systems for color TV studios from those first employed in monochrome television. A typical system will then be studied along with quantitative design considerations. Dimmer and interconnection apparatus currently in use will be described, and the author will give his views on what the aims of future system designs should be and will tell of two new pieces of apparatus now under development. A number of slides of NBC lighting facilities will be shown.

**Xenon Lamps**

W. THOURET, Westinghouse

**Fluomeric Lamps for TV**

M. MACKSOUD, Duro-Test Co.

**Lighting for Opaques on TV**

H. N. KOZANOWSKI, Radio Corp. of America, Camden, N.J.

The use of 3-V Film Cameras to provide high-quality color TV reproduction of color opaques has brought new requirements for lighting sources. These must cover uniformly a limited field at light levels of the order of 10,000 ft-c. Such levels are currently in use for monochrome TV reproduction of opaques. Various methods of obtaining adequate illumination for color are compared.

## *MONDAY EVENING*
## A CONCURRENT SESSION
## 6:30 P.M. Tour of Du Mont Telecenter (I)

## *MONDAY EVENING*
## A CONCURRENT SESSION
## 7:00 P.M. Laboratory Practice Session (III)

**A 16mm Color Internegative Film for Use in Color Motion-Picture Photography**

D. M. ZWICK, H. J. BELLO and C. E. OSBORNE, Eastman Kodak Co., Rochester, N.Y.

A color film for use in making 16mm motion-picture internegatives from Kodachrome and other reversal originals is described. These internegatives can be used to produce release prints on color positive film such as Eastman Color Print Film, Type 7382. The internegative contains colored couplers to provide masking for improvement in color reproduction. Film structure, processing and sensitometric characteristics, and printing characteristics are described.

**Silver Soundtracks on a Reversal Color Print Film**

ROBERT C. LOVICK and RICHARD L. WHITE, Eastman Kodak Co., Rochester, N.Y.

This paper discusses methods of obtaining positive silver soundtracks on reversal color films. Data are given concerning the requirements of negatives and internegatives for soundtrack printing, exposure balance determination and densitometry on Eastman Reversal Color Print Film. Data from distortion tests are presented for both normal and special negatives.

**Ion-Exchange Recovery of Eastman Color Developers**

JOHN H. PRIESTHOFF and JOHN G. STOTT, Eastman Kodak Co., Rochester, N.Y.

Generally, motion-picture processing machines are continuously replenished to maintain solution composition. The chemical cost of processing Eastman Color Negative and Eastman Color Print films can be reduced by recovering the overflow developers displaced by the replenisher and ordinarily discarded. The color negative and print developers are percolated through an ion exchange resin bed and the effluent solutions are reconstituted to replenisher composition. These rejuvenated developers are then suitable for use as replenishers.

**First U.S. Installation of Arri Color Developing Equipment**

ROBERT E. JOHNSON, Byron, Inc., Washington, D.C.

A modern positive-negative color developing installation built around the Arri Color Machine has recently been completed by Byron, Inc. This installation makes extensive use of polyvinyl chloride plastics both in machine design and auxiliary equipment. An existing building had to be completely modified before adding to an existing laboratory the new equipment, including chemical mix, control, and developing sections.

**Calibration of Color Motion-Picture Printers**

JACK E. PINNEY and WILLIAM R. WELLER, Eastman Kodak Co., Rochester, N.Y.

Knowledge of the relationship between printer light and Log E values is necessary for accurate color timing. Information relating color-correction or intensity-changing filters to Log E values is also needed. A method suitable for the calibration of both additive and subtractive motion-picture printers is given.

## *TUESDAY MORNING — MAY 1*
## 9:00 A.M. "Oklahoma!" Todd-AO—Rivoli Theatre

Dr. WALTER ZIGMUND, American Optical Co., will describe the process and introduce the film. During the showing, the projection booth will be open for inspection by qualified members. A technical staff, including installation experts, will be on hand to answer questions.

## *TUESDAY AFTERNOON*
## 2:00 P.M. Television Film Commercials Session

**Agency TV Departments and How They Function**

S. J. FROLICK, Fletcher D. Richards, Inc., New York.

**Writing the TV Commercial and Selecting a Producer**

PETER CARDOZA, Fuller & Smith & Ross, New York.

**What the Agency Expects of a Producer**

G. DAVID GUDEBROD, N. W. Ayer, New York.

**What the Producer Expects From an Agency**

ROBERT KLAEGER, Transfilm, Inc., New York.

## PANEL DISCUSSION

The authors of the above papers will be joined by:
WILLIAM ARLINGHAUS, Modern Talking Picture Service, New York
BEN BLOOM, Movielab, Inc., New York.
WILLIAM NEMETH, Movieoptics, Inc., New York.

This panel is representative of the many agency, studio and laboratory activities engaged in service-distribution of TV films, domestically and overseas; traffic and account control; opticals; spectacular color production; studio traffic; and laboratory control.

## *TUESDAY EVENING*
## 5:30 P.M. Tour of NBC Colonial Studio
## 6:30 P.M. Tour of Du Mont Telecenter (II)

## *WEDNESDAY MORNING — MAY 2*
## A CONCURRENT SESSION
## 9:00 A.M. Television Studio Lighting Session II— Belmont Plaza Hotel

### Lighting Guide Posts (Film)
P. WITTLIG, CBS Television, New York.

### Monochrome Television Lighting Survey and Report
WM. R. McCOWN, WSM-TV, Nashville, Tenn.

On April 21, 1955, at a meeting of the Television Studio Lighting Committee in Chicago, it was recognized that information on the lighting practices of various stations would help in furthering committee projects. The Midwest Regional Subcommittee agreed to conduct a survey of some 341 stations in 25 states located in the Central Section of the country. The results of this survey are presented.

### Color TV Lighting Survey and Report
GERALD F. RESTER, Radio Corp. of America, Camden, N.J.

The purpose of this survey is to determine current lighting practices of TV stations engaged in live color-program origination. The ultimate goal is for the SMPTE Lighting Committee to make recommendations that might improve the state of the art. The findings of the survey are presented, broken down into the following categories: General, Studios, Lighting Materials, Personnel, Instrumentation, Make-Up, and Miscellaneous Problems and Comments. Brief observations and a summation are given.

### Lighting in Black-and-White at WSM-TV for a Future in Color
WM. R. McCOWN and JACK HOPKINS, WSM-TV, Nashville, Tenn.

This paper tells how one medium-sized station is handling its studio lighting, not only in color telecasting but also in feeding network programs to the rest of the country. It is not intended to be a critique on studio lighting, but, more especially, right or wrong, the story of how one station applies its six years' experience in practice, with the ever-present knowledge that color will one day take over in the studio.

### After Two Years of Local Color Origination
PHILIP W. WYGANT, WBAP-TV, Fort Worth, Texas.

Wattage per square foot of studio floor space was increased from 18.5 to approximately 60. The air-conditioning capacity was almost doubled. A light level of 400 ft-c. has been found practical. Lighting for color is not so difficult as some might think. Most any person with an understanding of the capabilities and requisites of the color camera and with some artistic ability can light for a good color picture.

### Lighting the Network Color Productions
E. CARLTON WINCKLER, CBS Television, New York.

Because network programming usually includes greater scope of subject material than is possible on local stations, the lighting of these programs also presents a greater variety of problems. The lighting of larger areas and the variation of this lighting to accentuate a wide variety of moods and camera angles becomes of paramount importance. The technique developed in lighting network programs uses interesting combinations of all types of lighting equipment and a wide range of wattages to obtain the balance and the intensities necessary for the cameras while operating within the dramatic structure. These techniques and methods will be discussed in detail.

### A Comparison of Lighting Techniques Used in Live and Filmed Television Programs
CAMERON G. PIERCE, American Broadcasting Co., Los Angeles, Calif.

Lighting of films for television takes into account the idiosyncrasies of the television film reproducing camera and must supply proper reference to insure accurate reproduction of the original scene. Lighting of live programs must meet the requirements of the image orthicon camera and allow for electron redistribution, image ghosts, etc. Both of the above techniques include limitation of contrast range, control of average picture brightness and proper picture composition.

## *WEDNESDAY MORNING*
## A CONCURRENT SESSION
## 9:00 A.M. Report of the Activities of the Magnetic Sound Subcommittee of the Sound Committee— Status of Standards, Magnetic Test Films and Future Activities of the Subcommittee
ELLIS W. D'ARCY, Chairman

The number of frames by which the sound leads the picture on a 16mm film with magnetic track has been extensively debated. To give all interested parties an opportunity to air their opinions before current efforts at standardization crystallize, this session will include an open forum to which all broadcasters and equipment manufacturers affected by this question are invited.

## *WEDNESDAY AFTERNOON*
## A CONCURRENT SESSION
## 2:00 P.M. Television Studio Lighting Session III— Belmont Plaza Hotel

### Relation of Staging to TV Lighting
R. DAY, NBC

### The Art of Color TV
SALVATORE J. BONSIGNORE, CBS Television, New York.

Procedures outlined in this paper will attempt to compare black-and-white and color TV. Some procedures were developed and tested on a theoretical basis; others evolved after practical experience in color TV production. These techniques and procedures are offered with the intent of making commonplace the means for presenting creative color pictures which satisfy existing technical standards.

### TV Studio Illumination
W. WILSON, Westinghouse

### General Considerations of Lighting for Motion Pictures for Color Television
T. G. VEAL, Eastman Kodak Co., Rochester, N.Y.

The discussion outlines the considerations in lighting the scene of which color motion pictures are to be made for transmission over a color TV system. In making such pictures it is necessary to determine, in so far as possible, what technically constitutes a satisfactory picture for the purpose. To do this, it is necessary to examine critically the requirements of brightness, contrast, resolution, and color quality in photographing the scenes to make them suitable for television reproduction.

### Camera Matching and Illumination Control for Color TV
EDWARD P. BERTERO, National Broadcasting Co., New York.

In the development of color camera matching technique it was found inadvisable to use colored paper or other opaque material illuminated by direct front projection. The reasons are: (1) Illumination of the test chart is extremely critical in obtaining the exact values of each color chip on a day-to-day basis. (2) Generally, stable color papers do not have the degree of reproducibility in manufacture and the degree of saturation required for precise measurement purposes. A color camera alignment and matching technique has been developed using 8 × 10 transparent slides of both black-and-white and color. This technique required that the source of illumination for the slides be of the proper brightness and spectral response normally encountered on a live set.

### Switching and Controls for Black-and-White and Color TV Studios
JAMES THOMPSON, Century Lighting

### Economics of TV Lighting
GEORGE GILL, Gill Southern Associates, North Miami, Fla.

Providing fully adequate studio lighting facilities is compared with minimum lighting facilities by comparisons as to instrument types, beam types, use of accessory equipment, type and quantity of outlets, instrument selectivity and methods to adjust intensity. The minimum capital investments and operating costs are summarized along with the importance of studio time and labor costs in relocating lighting instruments and the importance of technical and artistic perfection of broadcast picture.

### West Coast Views of Monochrome TV Lighting
G. PETERSON, CBS, Hollywood.

# STEREOPHONIC SOUND* IS BETTER

## THAN ANY SINGLE CHANNEL SOUND

## *Give your customers the best*

Get the full dramatic brilliance of sound of today's top-rated motion pictures!

The new Westrex Stereophonic equipment reproduces the full range, tone and quality recorded on the film. This new equipment is simpler in design and cheaper to install and maintain. Prices are 5% to 30% lower than comparable 1955 equipment.

FOR THE BEST in multi- or single channel, magnetic or photographic sound systems ...buy

- **THE WESTREX**
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*Three channel, four channel, or six channel

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Hollywood Division: 6601 Romaine Street, Hollywood 38, Calif.

## *WEDNESDAY AFTERNOON*
## A CONCURRENT SESSION
## 2:00 P.M. Motion-Picture Equipment Session

**Automatic Film Inspection**

ROBERT GRUNWALD and RICHARD WALLACE, The Harwald Co., Evanston, Ill.

An automatic system for inspection of 16mm sound release prints is described. This system is embodied in the machines which have been in use in 16mm nontheatrical distribution for several years; recently a model for television use has been introduced. The application of these units to inspection and editing in various fields is discussed along with the principles of their operation.

**A Dual-Purpose Sound Synchronizer**

IRVING BROWNING, The Camera Mart, New York.

The Dual Sound Reader consists of a sound reproduction head, optical and magnetic, a separate base which will accommodate any motion-picture viewer, and a combination amplifier-speaker. It differs from other equipment of this nature in its wide range of applicable uses: for editing single- and double-system sound film in lip-synchronization; used from left to right or right to left; and with a mixing unit it can be used with two or more soundheads at the same time.

**A 35mm Projector for Color TV**

WILLY BORBERG and E. A. CALAMAI, General Precision Laboratory, Pleasantville, N.Y.

A 35mm projector for use with vidicon pickup tubes is described. Long light application pulses are made possible by a 2–3 intermittent movement with fast pulldown.

**High Efficiency Rear-Projection Screens**

C. R. DAILY, Paramount Pictures Corp., Hollywood.

Using a new type of high efficiency rear-projection screen, a 40-ft. wide projected color picture can now be photographed on standard Eastman Color Negative Film, Type 5248, with the camera operating at *f*/4 at 24 frames/sec. Data will be presented on the transmission and reflectance characteristics of this new screen, together with data on several other experimental screens which have wide-angle and high-transmission characteristics.

**Film Projection With Large Reels**

JASPER S. CHANDLER, Eastman Kodak Co., Rochester, N.Y.

The concept of "effective weight" is developed as a means of rating reels according to their relative film damaging potential. Useful relationships between size, capacity, stiffness, weight and effective weight are presented for all 16mm reel sizes. The importance of a large ratio of core diameter to outside diameter for the reel is stressed. Some standardization proposals and design features of the projector for use with large reels are suggested.

**Film: Early Projector Mechanisms**

DON MALKAMES, Tuckahoe, N.Y.

This is a 2000-ft black-and-white 35mm film made in the interests of projection history.

**Film: Film Firsts**

PAUL KILLIAM, "Movie Museum," New York

An informal talk of historical interest illustrated by film clips of vintage 1895 to 1915, demonstrating early examples of creative cinematography—cross cutting, moving camera, animation, experimental sound, close-ups, color, reconstructed Boer War news events, etc. Are these "firsts," or can still earlier examples be discovered? Were they brought about by genius or sheer necessity?

## *WEDNESDAY EVENING*
## 7:00 P.M. Underwater Television Session

**Remote Control Apparatus for Television Cameras**

J. D. ROBINSON, American Machine & Foundry Co., Greenwich, Conn.

**Underwater Observation by Television**

EDWIN A. LINK, Link Aviation Inc., Binghamton, N.Y.

A practical application of television in underwater exploration will describe expedition to Silver Shoals by Mr. Link in his motor vessel "Sea Diver." His presentation will relate the history of loss of the vessel "Nuestra Senora," the treasure recovery by Capt. William Phipps, in 1688, and contrast the Phipps and Link methods. A color film will record the 1955 Silver Shoals expedition.

**Underwater Exploration by Television**

DOUGLAS ALLANSON, Pye Limited, Cambridge, England.

Problems in underwater observation are outlined to permit an appraisal of the usefulness of television applied to this field. The advantages and limitations of television are presented and an attempt is made to draw up an ideal specification. A general-purpose camera based upon this specification is described. The problems of lighting and application are discussed and future trends in design are suggested.

## *THURSDAY MORNING — MAY 3*
## A CONCURRENT SESSION
## 9:00 A.M. High-Speed Photography Session I

**Multiflash Microsecond Flash**

FREDERICK BARSTOW and HAROLD E. EDGERTON, Edgerton, Germeshausen, and Grier, Inc., Boston, Mass.

Equipment that produces 20 flashes of light at controlled intervals is described. Each flash has a duration of about one microsecond and a peak intensity of 600 kilocandle power. The interval between flashes is controlled by an oscillator. The minimum interval between flashes is 10 μsec. Triggering is arranged by a voltage signal such as from a photoelectric cell or microphone. Examples showing bullets are used as illustrations.

**Television Picture Tube Implosions**

PAUL A. KRISTENSEN, Engineering Extension Service, Iowa State College, Ames, Iowa.

This is a film showing high-speed photographs of implosions of various TV picture tubes. It was taken with a Wollensak Fastax high-speed camera. After some of the implosions, the resulting pieces of glass and distances at which they fell are shown. This film is guaranteed to instill in the viewer a healthy respect for the dangers of mishandling picture tubes. A narration over the film will be provided.

**The Maintenance Problem Forecaster in Automation**

N. W. RODELIUS, Armour Research Foundation, Evanston, Ill.

Repeated machinery failures in large industrial plants can be predicted and solved by an engineering study of high-speed and regular motion pictures of production equipment. It is the intent of this paper to point out that, with the introduction of automation, plant maintenance engineers will be required to anticipate and prevent breakdowns.

**Kodak Films for High-Speed Motion-Picture Photography**

WAYNE E. HUMM and A. EARL QUINN, Eastman Kodak Co., Rochester, N.Y.

During the past year new Kodak films have become available that are particularly suitable for use in high-speed photography. The purpose of this paper is to present the sensitometric relationships of the various films presently available from the standpoint of both conventional sensitometry and high-intensity, short-exposure time, flash-lamp sensitometry. The films which are suitable for both reversal and negative use are included in both the reversal and negative test comparisons. Practical high-speed camera picture tests are shown. The films considered are Cine-Kodak Super-XX, Cine-Kodak Plus-X Reversal, Cine-Kodak Tri-X Reversal, Kodak Linagraph Pan (both old and improved types) and Cine-Kodak High-Speed Infrared.

## *THURSDAY MORNING*
## A CONCURRENT SESSION
## 9:00 A.M. Sound Recording Session I

**Resynchronizing Optical Tracks with Tape**

RICHARD H. RANGER, Rangertone, Inc., Newark, N.J.

Sound and picture put over the story so much better when well synchronized, that any steps which improve this lock-in are worth while. With sound not simultaneously recorded with the picture taking, the problem becomes increasingly difficult. Sound on tape offers the advantage of normal accurate lock-in, but also offers the opportunity of fluid adjustment when necessary. A method of dividing the recorded sound into two alternate tapes used in much the same manner as A and B rolls gives a facility for adjusted timing during the inactive slugs in each tape to permit very close synchronizing, with no speed changes in the actual reproduced sound.

**Editorial Sync Conversion Equipment for Single-System Magnetic-Sound Cameras**

ELLIS W. D'ARCY, EDL Company, Gary, Ind.

The paper describes a magnetic-sound camera conversion and a sync-point shifting apparatus. The paper analyzes the various proposals for securing editorial (dead) sync on single-system magnetic-sound picture negatives, and describes equipment designed to secure dead sync for editing purposes and an apparatus for subsequent sync-point relocation for standard-sync lead distance, for release purposes. It also introduces a dead-sync viewer-type of magnetic-sound editing equipment.

**The Opti-Mag Film and System**

C. ROBERT FINE and ELMER O. WILSCHKE, Fine Sound, Inc., New York.

Opti-Mag has been developed to facilitate editing and mixing by continuing the convenient practice of editing optically and permitting the desirable features of mixing from magnetic film. The optical soundtrack is engraved on a specially prepared lacquer coating on normal safety-base film and requires no processing. The magnetic coating is standard magnetic coating as supplied on commercial 35mm magnetic film. The optical and magnetic tracks are recorded simultaneously, and since the optical modulation is adjacent and coincident to the equal magnetic information, the film can be cut straight across for editing and splicing. This paper has been prepared to show the versatility of the combined optical-magnetic film and to describe the process and the equipment involved.

**An Audio Flutter Weighting Network**

FRANK A. COMERCI and ELISEO OLIVEROS, Material Laboratory, New York Naval Shipyard, Brooklyn, N.Y.

Listener preference rankings of selected samples of programs containing many types of flutter will be compared to measurements of the same flutter using a meter weighted with respect to flutter rate in accordance with the threshold of perceptibility. It is shown that the correct weighting curve varies with the level of flutter and that modification should be made to the flutter meter in order to obtain objective rankings of various types of flutter which will agree with subjective rankings of program containing the same type of flutter.

**A Completely Self-Contained, Hand-Held, 16mm Single-System Magnetic-Sound Camera**

LOWELL A. WILKINS, Magnetic Sound Camera Corp., Chicago.

A completely new 16mm single-system magnetic-sound camera is described. The camera has a transistor audio amplifier, a transistor bias oscillator, and power supply for both, built inside the camera body. The VU meter is built inside the viewfinder. The camera's light weight, compact design, and its ability to record high-quality single-system magnetic sound make it a very useful unit for television, newsreel work, educational films and related fields.

**Magnetic 16mm Single-System Sound-on-Film Recording Camera Equipment**

W. BACH, E. M. BERNDT, A. N. BROWN and R. L. GEORGE, Berndt-Bach Inc., Los Angeles.

A new single-system camera method is described for simultaneously recording a high-fidelity magnetic 16mm soundtrack lip-synchronized with an optical picture in color or black-and-white, for magnetic 16mm single-system sound recording of live-pickup reproduction quality, instant monitoring of the soundtrack being recorded in the camera, together with greatly increased flexibility of picture processing. A demonstration film with lip-synchronized magnetic sound will be projected.

**Periodic Testing of Audio Equipment**

MAURO ZAMBUTO, Transound Inc., New York

A new audio test cabinet for comprehensively testing professional recording and broadcasting equipment.

## *THURSDAY AFTERNOON*
## A CONCURRENT SESSION
## 2:00 P.M. Sound Recording Session II

**PANEL DISCUSSION**
**The Use of Pre-Striped Magnetic Film**

ELLIS W. D'ARCY (Moderator), EDL Company, Gary, Ind.
WALTER BACH, Berndt-Bach
EDWARD SCHMIDT, Reeves Soundcraft Corp., Springdale, Conn.
GARLAND C. MISENER, Capital Film Laboratories, Washington, D.C.
JOHN FORREST, ANSCO, Binghamton, N.Y.
R. F. DUBBE, Minnesota Mining & Mfg. Co., St. Paul, Minn.
GEORGE LEWIN, Army Pictorial Center, L.I.C., N.Y.

## *THURSDAY AFTERNOON*
## A CONCURRENT SESSION
## 2:00 P.M. High-Speed Photography Session II

**A New Missile Scoring Camera**

ROBERT D. SHOBERG, Wollensak Optical Co., Rochester, N.Y.

**INSPECT-O-FILM**

Automatically detects torn or enlarged sprocket holes, sprocket punch, broken film, weak splices or any defect that would cause a poor showing. Counts good splices and cleans film. Try automatic film inspection for just $75 a month and assure your customers perfect show every time. Model K (pictured above) is complete with editing facility; trial rental slightly higher. Write for descriptive literature.

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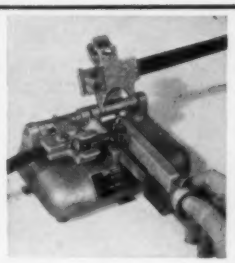
Works four ways to increase film life, improve projection quality. Cleans completely, reduces wear, prevents dirt and dust collection, strengthens film base. Try this amazing film conditioner yourself. Pint, just $1.75.



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**Environmental Test of High-Speed Camera**

CARL J. BRASSER, Fairchild Camera & Instrument, New York

**Plans for the Third International High-Speed Photography Congress (A Report)**

JOHN H. WADDELL, Fairchild Camera & Instrument, New York

## *THURSDAY EVENING*
## 6:45 P.M. Cocktails
## 8:00 P.M. Banquet and Dance (black tie preferred)

## *FRIDAY MORNING — MAY 4*
## 9:00 A.M. Television Session I

**New Zoom Lens Developments for Telecasting and Industrial TV**

FRANK G. BACK, Zoomar, Inc., Glen Cove, N.Y.

A new type of Zoomar will be demonstrated which has a zoom ratio of more than 1:6. This new Zoomar is manufactured in two models, one for image-orthicon cameras with a range from 2½ to 16 in. and one for vidicon cameras with a range from 20mm to 120mm.

**Optical Problems in Industrial and Institutional TV**

JOSEPH W. BELCHER, General Precision Laboratory Inc., Pleasantville, N.Y.

Some interesting optical problems in connection with vidicon pickup equipment will be discussed from a practical viewpoint telling how they arose and the solution.

**Recent Improvements in Black-and-White Film Recording for Color TV**

WILLIAM L. HUGHES, Engineering Experiment Station, Iowa State College, Ames, Iowa

At the 1955 SMPTE Convention at Chicago, a method of recording color television images on black-and-white film was described. At that time, certain difficulties regarding light efficiency, noise, and image definition were yet to be resolved. In the last year, refinements have been made in the electronic and optical characteristics of the system to the extent that the overall picture quality now compares very favorably with that obtainable on 16mm color film. This paper is concerned with a discussion of how these refinements were achieved. Several color slides of "before" and "after" pictures will be shown. These slides will be taken from a dichroic display and will represent the overall results obtainable from the system.

**Color Kinescope Recording on Embossed Film**

C. H. EVANS and R. B. SMITH, Eastman Kodak Co., Rochester, N.Y.

In the past, a special form of black-and-white film with tiny cylindrical lenses embossed in its base has been employed in conjunction with a banded color filter for additive color photography. Such film is readily adaptable to color kinescope recording, and in this application the banded filter is not required. Color aspects of the problem can be reserved to the television system. The advantages of color kinescope recording on embossed film include economy, faithful color reproduction, high efficiency and rapid film processing. The latter is particularly important in meeting the demands of time-zone-delayed broadcasting or "quick kine." Prints for subsequent distribution can be made on ordinary subtractive color films.

## *FRIDAY AFTERNOON*
## 2:00 P.M. Television Session II

**Closed-Circuit TV Theme**

KEN THOMAS, Special Devices Center, Office of Naval Research, Port Washington, N.Y.

The paper will discuss the present technical state of readiness of instructional closed-circuit television, refer to potential support from the built-in TV communication habit among those it would serve, and discuss research in TV applications to help improve the volume and accuracy of communication. It will then identify some present obstacles to widespread use, discuss them, and conclude with the presentation of a tested procedure for planning instructional closed-circuit television.

**The Luminance of Subjective Black**

E. M. LOWRY and J. G. JARVIS, Eastman Kodak Co., Rochester, N.Y.

The subjective phase of tone reproduction requires a knowledge of how the eye reacts; that is, the visual response under a given set of conditions. Two instruments which have proved useful for obtaining this knowledge are described. They are the visual sensitometer and the adaptometer. The particular response investigated and reported is the luminance of subjective black, which may be defined as that value of luminance which is just too low to produce a perceptible visual impression under the luminance distribution existing in the scene being viewed. A fairly simple empirical scheme is proposed for predicting the luminance of subjective black from two easily measured quantities: the luminance of the fixation point and the average scene luminance.

**Closed Circuit TV, Its Practical Installation and Operation**

JOHN R. HOWLAND, Dage TV Div., Thompson Products Inc., Michigan City, Ind.

Closed circuit television involves techniques less complicated than those required of standard broadcasting. Its field of use grows where its unique service is adapted to local requirements and is performed adequately at reasonable cost. Practical installation requires critical analysis of the particular mission, which will differ, for instance, in the bank, the warehouse, the school laboratory and the school lecture room. Practical operation requires a realistic system and schedule of use and a comprehensive plan of maintenance.

**Television as a Military Intelligence and Communications Medium**

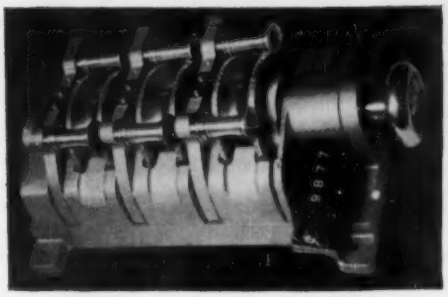
Lt. Col. NORMAN GRAY and Lt. JAMES C. JANGARATHIS, Army Pictorial Center, Long Island City, N.Y.

The continuing need for a more efficient intelligence system in the modern army is focusing attention on television as a basic means of communications. This paper summarizes some of the proposed applications for military television, describes types of current interim mobile television units, and presents recent maneuver utilization of 2 units.

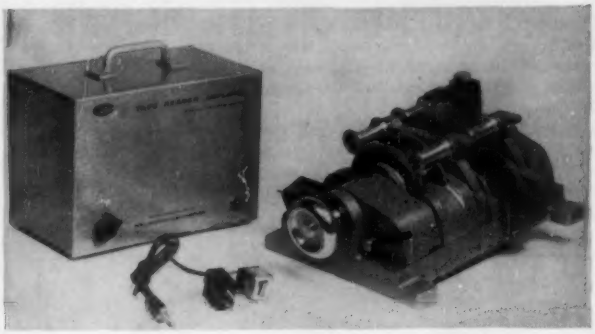
**Atomic Reactor Construction—A Time-Lapse Film**

NELSON W. RODELIUS, Armour Research Foundation, Chicago

# SYNCHRONIZER HEAVEN



35mm 3-Way Synchronizer **$165.00**



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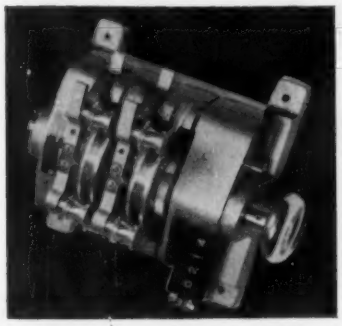
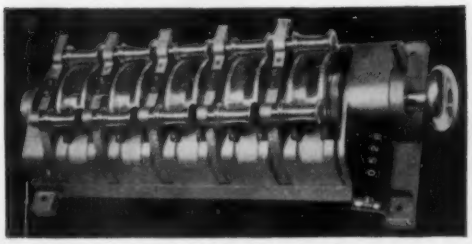


16mm 2-Way Synchronizer **$125.00**



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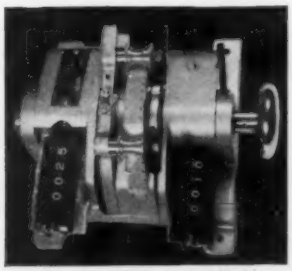

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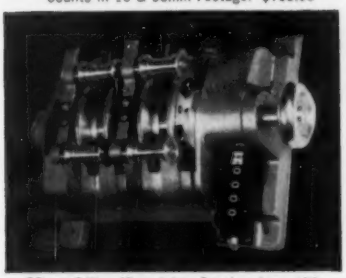

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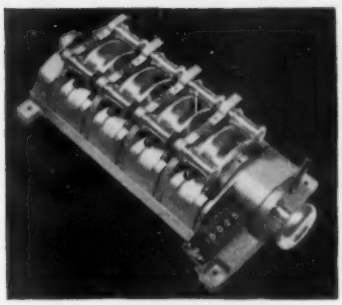
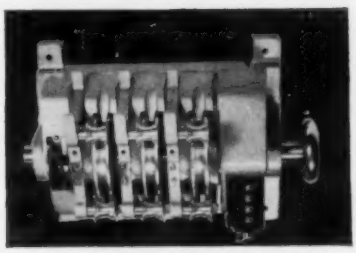
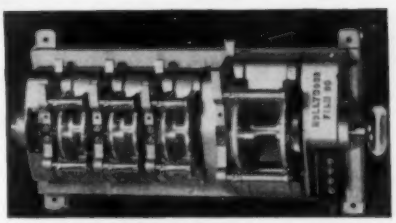


35mm 4-Way Synchronizer **$190.00**



16mm 3-Way Synchronizer **$165.00**



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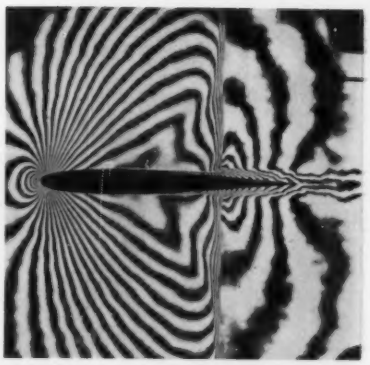
## Third International Congress on High-Speed Photography

The Third International Congress on High-Speed Photography will be held Sept. 10–15, 1956, at Government Offices, Horse Guards Ave., London, S.W.1, under sponsorship of the Department of Scientific and Industrial Research, the British Ministry of Supply. Sir Ben Lockspeiser, who is Secretary of the Department, will serve as President of the Congress and Chairman of the Congress Council.

The following are represented on the Congress Council: British Kinematograph Society, British Universities Film Council, Electrical Research Assn., Inst. of British Photographers, Inst. of Physics, Inst. of Electrical Engineers, Inst. of Mechanical Engineers, Inst. of Production Engineers, Ministry of Supply, Physical Society, Royal Photographic Society of Great Britain, Scientific Film Assn., Scientific Instrument Mfrs. Assn., and Society of Motion Picture and Television Engineers.

Much of the progress in technique and applications which has been made in high-speed photography during the past ten years will be discussed and demonstrated, with the interest centering on developments since the First International Congress in Washington in 1952 and the second in Paris in 1954. The main topics scheduled are:



**Interferogram, 1 μsec spark exposure, symmetrical aerofoil, zero incidence, M = 0.9. (Aero Division, N.P.L.)**

*Advances in Techniques Since 1952*

1. Flashlight sources,
2. Inertialess shutters,
3. Mechanical-optical drum cameras,
4. Image-sampling techniques,
5. Schlieren, interferometric, stereoscopic, color, photomicrography, radiography, etc.
6. Medium repetition rate cameras, and
7. Associated instrument aids.

*New Applications Since 1952*

1. Biology and medicine,
2. Industrial machine analysis,
3. Ballistics and explosions (including nuclear research),
4. Aero- and hydrodynamic research,
5. Underwater work,
6. Methods of evaluating films (frame analysis), and
7. Other applications.

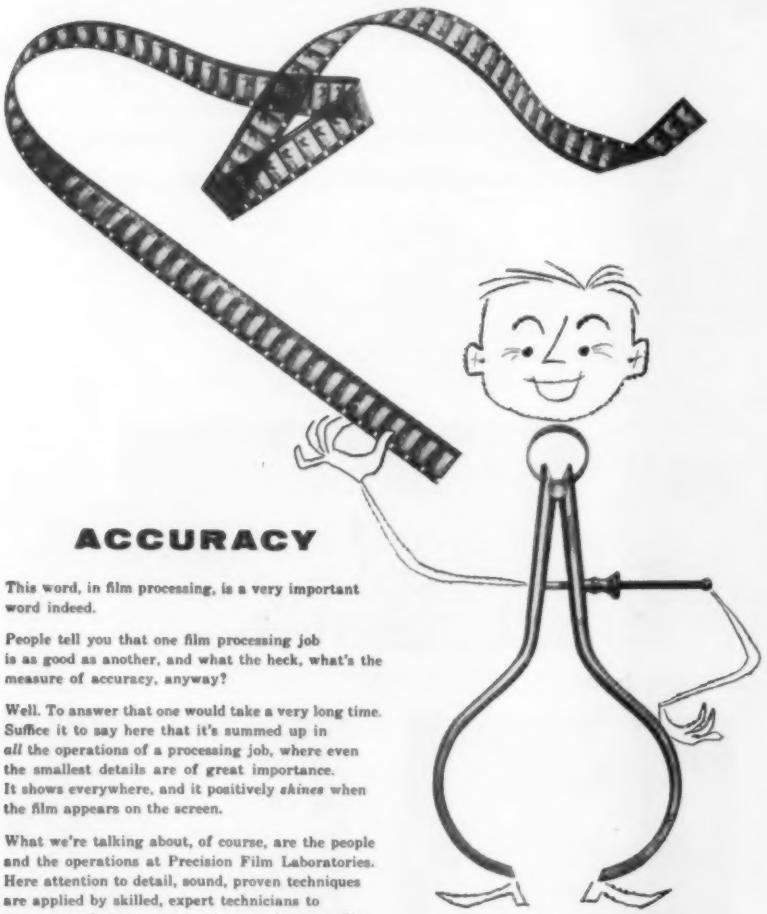
*Papers, which will be issued in preprint form to all Congress members, will not be read in full, but will be introduced briefly by their authors prior to discussion of them.*

An International Exhibition of recent developments in the fields listed under Congress topics will present research and commercial exhibits from universities, government research establishments, private firms and industrial research organizations.

For registration as a member of the Congress, or for information regarding exhibit space and charges, address:

The Secretariat
Third International Congress on High-Speed Photography
Charles House, 5–11 Regent St.,
London, S.W.1

The registration fee, which covers the cost of preprints of papers and of attendance, is approximately $20.00 (6 pounds, 10 shillings). SMPTE President Frayne early expressed this Society's willingness to co-sponsor American participation in the Congress, and John Waddell, of the High-Speed Photography Committee, has initiated preliminary discussions with Pan American Airways relative to the chartering of planes. If adopted, this chartering service would serve for the trip to London

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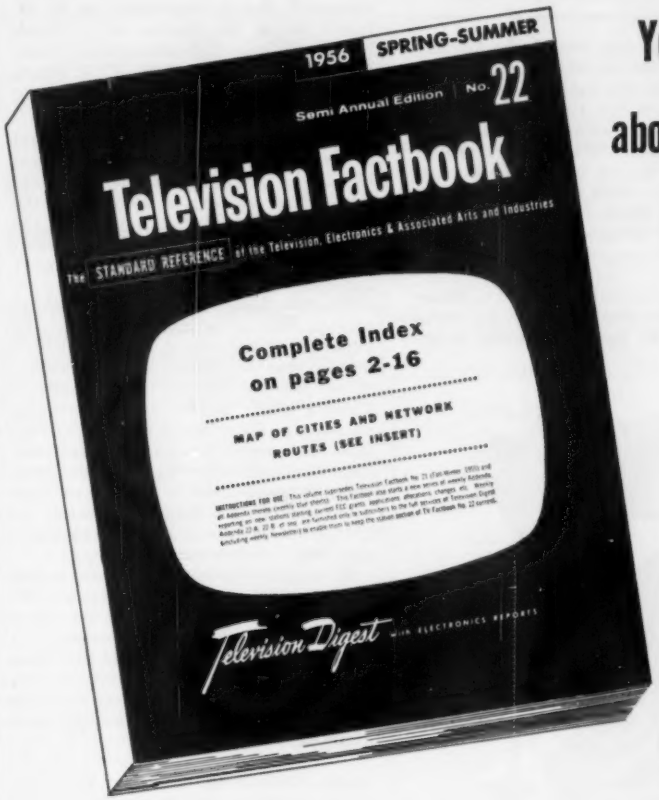
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Television Factbook
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Complete Index on pages 2-16
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for September 10–15, and would enable participants to visit Amsterdam, Paris and Cologne before returning to the United States. Cologne is high on the itinerary of Society members and other American participants because of the Photokina Exhibition which is scheduled to open there shortly after the Congress in London adjourns.

Richard O. Painter, Chairman of the SMPTE Committee on High-Speed Photography, will serve as the Society's official representative on the Congress Council. Details regarding the Society's and other American participation in the Congress will be discussed during the forthcoming SMPTE Convention in New York, April 30–May 4, 1956.

## Education, Industry News

**The newest Society award,** the Herbert T. Kalmus Gold Medal, was recently incorporated into the Society's administrative procedures by President John G. Frayne, who appointed a six-man committee to select the 1956 winner. Presentation of the award will be made for the first time at the Society's 80th convention in Los Angeles in October. The Kalmus award was conceived to honor major contributors to the scientific progress of color in motion pictures.

The Committee is as follows: Dr. Deane R. White of Du Pont, Parlin, N.J., Chairman; Dr. C. R. Daily, Paramount, Hollywood; William F. Kelley, Motion Picture Research Council, Hollywood; Dr. H. H. Duerr, Ansco, Binghamton, N.Y.; Frank N. Gillette, General Precision Laboratories, Pleasantville, N.Y.; and Dr. C. J. Staud, Eastman Kodak, Rochester, N.Y.

**Otto Wittel,** superintendent of general development in the Apparatus and Optical Division of the Eastman Kodak Co., has retired after 34 years of service with the company. His work has resulted in 130 patents which have made an important contribution to the development of Kodak apparatus.

Mr. Wittel jointed the Hawk-Eye Works plant in 1920 as an instrument maker. In 1924 he transferred to the company's development department at Kodak Office. When this department was moved to Camera Works in 1944, Mr. Wittel was named supervising design engineer. He became department head in 1947 and chief engineer the following year. He was named senior design associate in 1951 and assistant superintendent of design engineering in 1953, a year later becoming superintendent of general development.

He is a member of the Rochester section of the Optical Society of America, and the Society of Motion Picture and Television Engineers. He was born in Germany and came to the United States at an early age. His residence is at 33 Bellehurst Drive, Irondequoit, N.Y. A son, George Wittel, is a production staff member in the Apparatus and Optical Division.

**Andre Debrie of America, Inc.,** has appointed Edgar M. Burlin as the new president of the company. Until the recent death of Hans R. Kossman, who had been General Manager of the company since its formation in 1943, Mr. Burlin had been Vice-President, in charge of the Hollywood office. His connection with the French company dates from 1925, when he handled the equipment in Germany before coming to this country. Jules Boyer, who has been with Debrie for many years, has been named Technical Director, and will head a newly formed service department.

The company now plans to extend its activities on this side of the Atlantic. In addition to the headquarters office at 1947 Broadway, New York 23, the Hollywood office will be continued; in Canada, Canadian Microfilming Co., Ltd., of Montreal, will take over the agency; and Clifford E. Mattox, 209 Beverly Rd., Cocoa Beach, Fla., will represent the company in the southeastern states.

The company is at present putting emphasis on designing equipment, to be available by the end of 1956, for use in connection with the VistaVision system. Revised and redesigned equipment, especially for color printing, which has been developed in the company's research laboratories in France in consultation with experts from Eastman Kodak, Ansco and Ferrania, is being brought over for exhibit at the Society's Spring Convention in New York.

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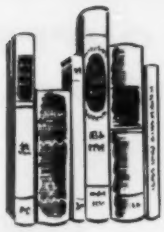

# books reviewed

### The Master Guide To Theatre Maintenance

By Aaron Nadell. Published (1955) by the Author, 130-57 Lefferts Blvd., South Ozone Park 20, L.I., N.Y. 240 pp. Illus. Graphs $4\frac{3}{4} \times 7$ in. $5.00.

The theatre manager to whom this book is addressed is described by the author as one of the "group of men who carry perhaps the most extensive and varied range of burdens of any group in the country . . . who is responsible for everything from the furnace in the cellar to the flashings of the roof." Nor, to judge from the contents, do the manager's activities stop at the building boundaries. The book gives him legal, accounting and insurance information; practical information on attracting patrons and keeping them; basic technical background on air conditioning, heating, projection and sound equipment; check lists of daily and seasonal tasks; practical methods of realizing operating economies; cleaning, painting and sanitation procedures; and more. The great amount of information that has been packed between the covers of this pocket-sized reference book is a gratifying tribute to the author's 25 years of experience in the field of motion-picture entertainment.—*Bernard D. Plakun*, General Precision Laboratory Inc., Pleasantville, N.Y.

### Data and Circuits of Television Receiving Valves

By J. Jager. Published (1953) Philips' Technical Library, distr. by Elsevier Press Inc., 155 E. 82 St., New York 28. 215 pp. Illus. Graphs. 6 × 9.

This new text is particularly devoted to the discussion of specific tubes (valves) which may be employed in modern high-quality television receivers. A great many receiver circuit diagrams are included, together with information as to the tubes (valves) which may be used to advantage in each circuit diagram. The tubes indicated are Philips tubes, of course, and this provides very useful information on some of the European tubes now in current use.

Three modern Philips direct-viewing picture tubes are described, the MW 36-44, the MS 36-24 and the MW 43-43. These television picture tubes are very similar in development to those currently in use in the United States, but the technical information given in the book is of extreme interest to any television engineer. The curves and graphs given throughout the text will be found very helpful.

It is thought that this new addition to the books included in the Philips Technical Library will be helpful and useful to any


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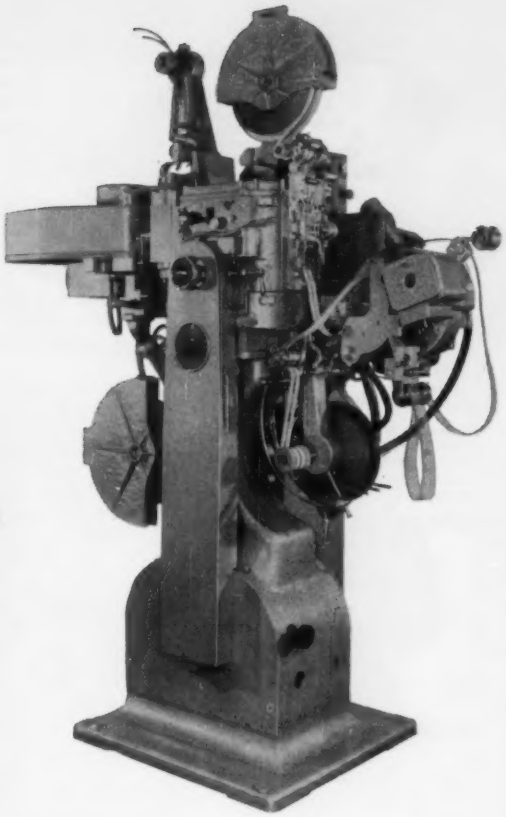

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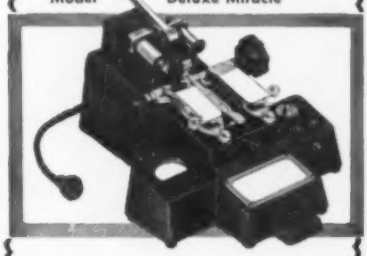

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television engineer who might add a copy to his collection of engineering texts. It is highly recommended to those who seek to acquire a knowledge of Philips television receiver valves (tubes), and their use in modern European receiver circuitry.—*Scott Helt*, Allen B. Du Mont Laboratories Inc., Clifton, N.J.

### The American Psychologist
**Vol. 10, No. 10, October 1955**

Published by American Psychological Assn. Reprints of this issue are available at 30 cents each from The American Psychologist, Prince & Lemon Sts., Lancaster, Pa.

This Special TV Issue of this magazine indicates the more than cursory interest now being taken in television by scholars in various subject matter areas. In addition to the mention of the vast audiences which television already reaches, it is pointed out that TV could be as "revolutionary as the book."

How limitless both the material and the audience is for Educational Television is emphasized by reference to two types of audiences not always mentioned: (1) "Suppose that big-screen TV were adapted for the use of so-called 'backward countries'; could it not telescope the time scale of the battle for literacy? What would be *new to the natives* would be the written alphabet"; (2) "Ideas in themselves are interesting, and one need not resort to 'stunts' to reach and hold an audience. We should not underestimate the TV audience."

All of the articles in this TV issue were written by outstanding leaders in education, television and educational television. The invaluable bibliographical section, entitled "Selected References in Educational Television," was prepared by Dr. Benjamin Shimberg of the Educational Testing Services, Princeton, N. J. Technicalities are not overlooked; industrial and professional cameras which use the Vidicon pickup tube is recommended in preference to the luxury broadcast equipment of commercial television.

TV is young, and ETV brand new. Cooperation and tolerance on the part of educators, television and audience is necessary for ETV to have a chance to mature.—*Harry J. Skornia*, National Association Educational Broadcasters, Urbana, Ill.

**The Journal of the American Society of Safety Engineers** is a new publishing venture of the ASSE. Volume 1, Number 1 has appeared, dated February 1956.

Edward B. Landry, President of ASSE, has announced that the professional aim of the publication is to give safety engineers, management officials and others information on the prevention of accidents and better application of safety engineering principles, with technical articles to be directed at supplying new knowledge on developments from research and on-the-job experience. J. B. Johnson is secretary of the American Society of Safety Engineers and manages the society and its activities. The editor of the new publication is Robert E. Beighley, and the associate editor is Charles S. Wolff. ASSE headquarters are at 425 North Michigan Ave., Chicago 11.

# current literature

**The Editors present for convenient reference a list of articles dealing with subjects cognate to motion-picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.**

**American Cinematographer** vol. 37, Jan. 1956
Photographic Preproduction Tests (p. 24) *J. Ruttenberg*
Current Techniques of 35mm Color Film Photography and Printing (p. 26)
A New Method of Insert Cinematography (p. 28) *J. Arnold*
A Simplified Method for Recording Magnetic Sound on 16mm Film (p. 38) *O. H. Horovitz*

**American Cinematographer** vol. 36, Dec. 1955
And Now 55mm (p. 706) C. G. Clarke
New Portable VistaVision Camera (p. 713) *A. Rowan*
Movie Studio in a Track (p. 714) *F. J. Roh, Jr.*
Magnetic Recording for Auricon Cameras (p. 717)
Filming with Filmorama (p. 718) *C. Harrington*

**Audio** vol. 40, Jan. 1956
High-quality Dual Channel Amplifier (p. 13) *C. W. Harrison, Jr.*

**British Kinematography** vol. 28, No. 1, Jan. 1956
Xenon Arc Discharge Lamps for Film and Television Industries (p. 5) *H. W. Cumming*
vol. 27, No. 6, Dec. 1955
Appreciation of the Origins of Cinematography (p. 171) *B. W. Coe*

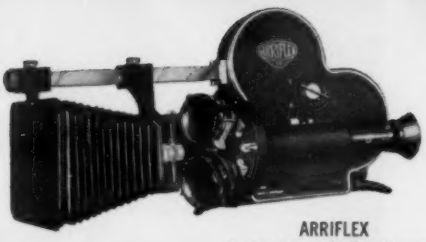
**International Photographer** vol. 28, Jan. 1956
Wide Screen Chronology (p. 5) *J. L. Limbacher*
Perspecta Sound System (p. 8) *R. A. Dupy*
VistaVision (p. 10) *L. L. Ryder*

**International Projectionist** vol. 30, Dec. 1955
RCA Reproduces Pictures by Magnetic Tape System (p. 18)
Portable Arclamp Equipment for 16mm Projection (p. 19) *R. S. Freeman*
1945 to 1955: Ten Years of Progress in Projection Technology (p. 21)

**Kino-Technik** vol. 9, Dec. 1955
Schmalfilm im Blickfeld. Neue Moglichkeiten durch den Ton (p. 460)
Universelles Schmalfilm-Tonsystem fur alle Verfahren (p. 463) *H. Schmidt*
Vertonung von 8mm-Schmalfilm mit dem "Synchromat" (p. 468) *W. W. Diefenbach*
Schmalfilm als wichtiger Faktor im Fernsehbetrieb (p. 470) *L. Furst*
Indexskalen und ihre Vorzuge fur die Aufnahmetechnik (p. 483)
Ein neuartiges Beleuchtungssystem fur Bildwerfer (p. 484) *H. G. Roscher*
Maschinen fur Negativ- und Umkehr-Entwicklung (p. 490) *W. Selle*

**Phillips Technical Review** vol. 17, No. 7–8, Jan.–Feb. 1956
The "Scenioscope," a New Television Camera Tube. P. Schagen, J. R. Boerman, J. H. J. Maartens and T. W. van Rijssel (p. 189)

**Radio & Television News** vol. 55, Jan. 1956
New G-E Color Picture Tube (p. 104)



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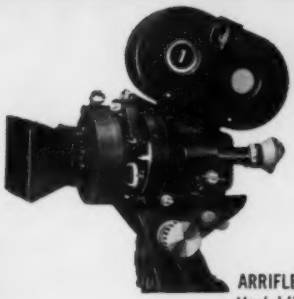

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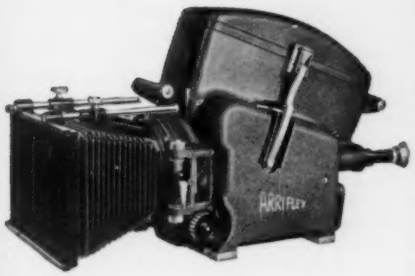

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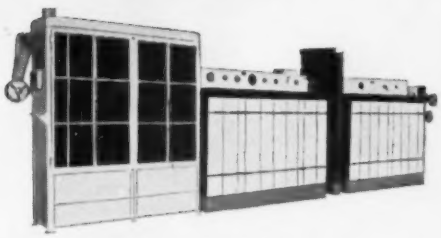

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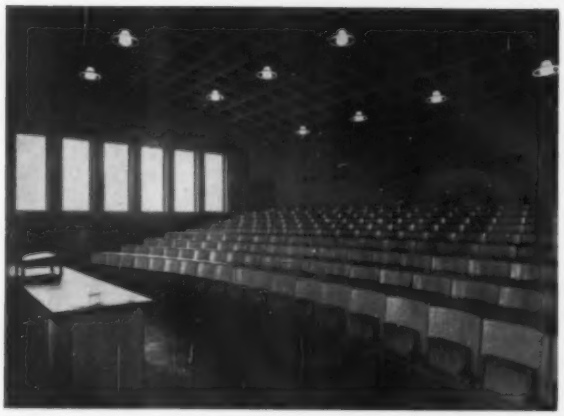

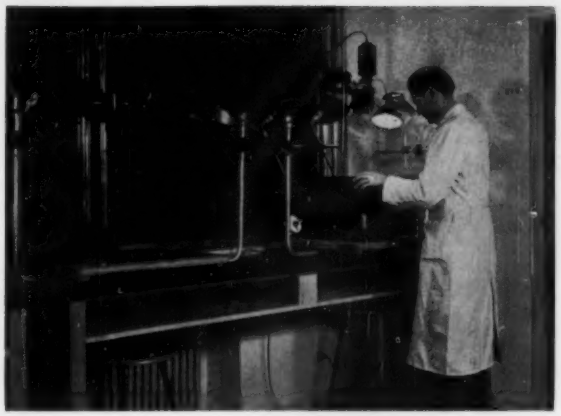

## German College of Photography

**The State College of Photography** (Staatliche Höhere Fachschule für Photographie) in Cologne, Germany, was opened in the spring of 1954, thus adding to the photographic renown of the city which is already the home of the annual photographic convention and exhibition known as Photokina. The industry in Germany has always given considerable attention to providing scientific and technical training for those entering the field, and the College continues this tradition. It is administered as a state institution by the State Government of North Rhine-Westphalia, with the active support of the city of Cologne and of the entire photographic industry.

The College's founders intend that the training provided there shall take fullest advantage of the progress made by the industry over the past few decades.

Optical and precision goods constitute a highly important part of West Germany's industrial output; education in the photographic sciences is desirable in this respect too. Trade and professional photographers today, faced with the complexity of modern techniques, realize the need for fundamentally different training from that considered adequate 20 years ago.

The new school offers a two-year course, with admissions at Easter only. Up to 80 students can be accommodated in the course. In addition to the regular courses, the College offers short refresher courses for those already in the industry.

To meet the needs of its students, the College carries a very full range of equipment. There are approximately 160 individual darkroom units, each fully equipped and provided with electricity and water connections, and for special areas such as optics and chemistry there is laboratory accommodation for 40 to 50 students. Classes are kept to a maximum of 20 students, so that with a full complement of students, first and second year, there are 8 classes operating simultaneously.

The College is planned to provide facilities for all the important techniques of applied photography. Large studios are available, equipped with power supply up to 100 kw, and with adjustable partitions, permitting as many as 16 groups of students to work with everything from regular studio cameras down to miniatures, with every type of modern lighting facility. In the processing lab, which can accommodate 20 students, the equipment is arranged so as to permit individual work; in addition there are several darkrooms with tanks for large-scale processing. Several different processing systems are included, so that the students can become familiar with all of them. For work with positives, there are two rooms with facilities for 20 students, and a series of smaller rooms for special work.

Special attention has been given to color processing, and every practical system available on the market is included. There are 18 darkrooms equipped with the finest modern apparatus, with room for 36 students, and a special color processing tank with thermostatic temperature control.

Separate departments are set up to handle document reproduction, microphotography and photoengraving up to the preparation of negatives for etching.

Film techniques, using both 16mm and 8-mm equipment, are studied in all four semesters of the course, particularly in view of the growing demand for 16mm in industrial photography. The College has several 16mm sound systems, including magnetic, and a large variety of 16mm and 8mm taking and projection equipment.

Worthy of mention also are an optical laboratory with equipment for lens testing and for measuring the resolving power of photographic materials; a chemical laboratory; and a sensitometry department. There are several lecture rooms, including one which is outfitted as a small motion-


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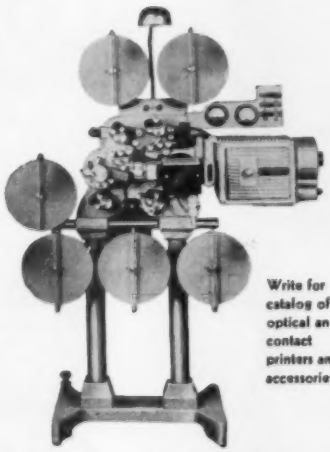

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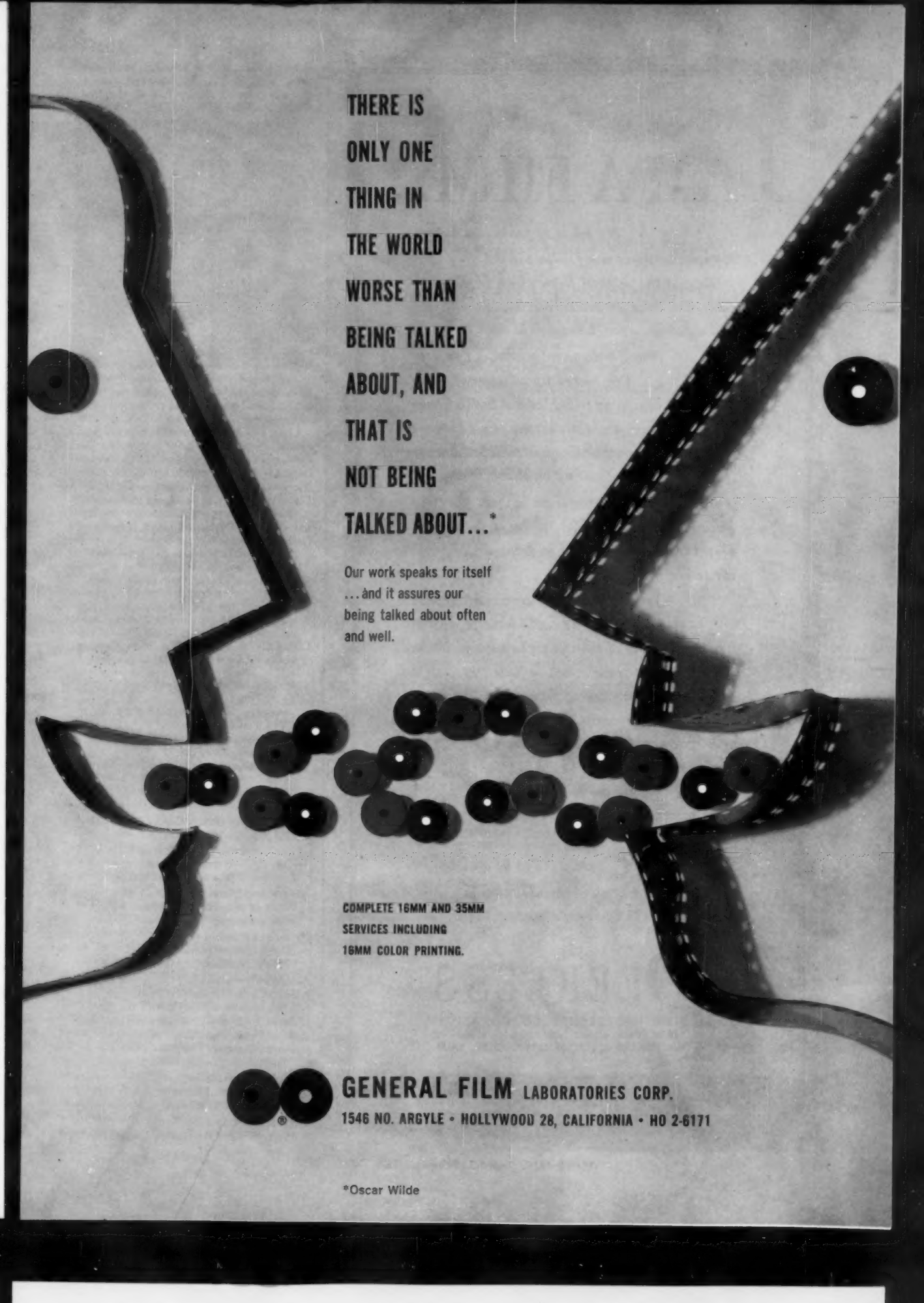
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picture theater to seat 300, with projection room and built-in loudspeaker system. A well-equipped library has all the best publications in German, English and French on photographic techniques.

There is no dormitory for the students, who for the most part rent private accommodation in the town, as is customary at German universities. Lunch is provided at the College.

The curriculum includes both theory and practice. Of total hours of instruction, some 60% during the first year and 70% during the second are spent in practical exercises. The theory classes cover the fundamentals of photography — optics, physico-chemical principles of the photographic process, chemistry, electricity, chromatology and color photography, lighting techniques — and also a certain amount of commercial instruction, pictorial composition and criticism. Sound on film, using the latest 16mm magnetic sound systems, is included in the second year of the course. For students interested in studio photography there are classes in drawing and artistic pictorial composition.

Complete details about the courses cannot be given in this brief report, but the College will be happy to supply further information on request. With its excellent equipment and ample accommodation, the College has already attracted numbers of students from all over the world.—*Dr. Ing. Leo Busch*, Gyrhofstrasse 6, Cologne, Germany.

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- Sound-Service Test Film
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**Sound only—16mm**
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**Picture Only—16mm**
- Steadiness Test Film
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- Projector Lens Resolution Target

## Obituaries

**Hans R. Kossman,** Vice-President and General Manager of Andre Debrie of America, Inc., died in New York on February 13, 1956. He was 54 years old.

Mr. Kossman, long a familiar figure at meetings of the Society, had been connected with the Andre Debrie Company since 1927, shortly after his arrival in this country from Germany. At the Spring 1933 Convention of the Society he presented a paper on Debrie equipment, and this was followed by other papers in 1934 and 1936. Contact with the French company was interrupted by the war, and in 1943 Andre Debrie of America was incorporated with exclusive sales rights for Debrie equipment in the U.S., Canada and Mexico. At recent conventions where there were equipment exhibits Mr. Kossman was always on hand to explain and demonstrate the Debrie products.

At the Lake Placid Convention last October he escorted Andre Debrie and his party, on the occasion of M. Debrie's installation as an Honorary Member of the Society.

**Samuel B. Grimson,** President of the Color Research Corp., died on November 29, 1955, in New York. Mr. Grimson was born in London where he studied at the Royal College of Music; he was a concert violinist on the continent and in the United States until World War I, when he was severely wounded. Subsequently, he devoted himself to research work in color photography and its application to the field of motion pictures and television. Numerous U.S. patents attest his inventiveness.

In his laboratory Mr. Grimson developed methods and processes aimed at the improvement and simplification of color rendition by straightforward optical means, in particular by eliminating the organic dyes with their inherent spectral deficiencies. On a laboratory scale, he was very successful in achieving good color separation on single-frame commercial panchromatic negative film. His method consisted in photographing the object by means of conventional optics through a banded, additive filter combination. Two-dimensional separation on the film was then

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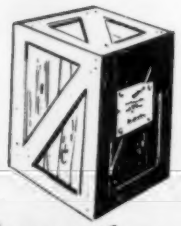
achieved by the use of diffraction or line gratings built into the camera as an integral part and at a short distance from the focal plane. For reproduction a similar optical system was used in reversed order.

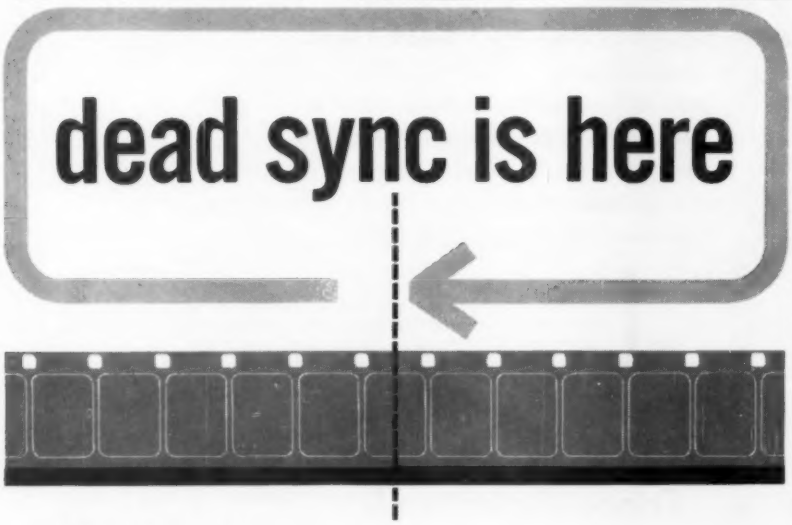
Color Research Corporation was recently reorganized as Grimson Color, Inc. Mr. Grimson had been a member of this Society since 1940 and was also a member of the Optical Society of America, The Society of Applied Spectroscopy, The American Institute of Physics and the New York Academy of Sciences.



# new products (and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

**The Auto-Zoom Model TV 16** is a new variable focal length lens especially designed for commercial and industrial television cameras using the vidicon-type tube. It is a product of the Perkin-Elmer Corp., Norwalk, Conn. The focal length is variable from 30mm to 150mm, a ratio of 5 to 1, and the lens can focus on any object from 6 ft to infinity. The lens system is moved from one end to the other of its focal length by motor-drive controls. Lens speed varies from $f/2.7$ at the short focal length and halfway through the range, to $f/4.7$ at the long focal length. Constant aperture is automatically held during the zoom range for any setting from $f/4.7$ to $f/11$. Zooming and focusing operations can be done remotely through the motorized drives. Motorized control of the iris setting may also be obtained as an extra price feature. The Auto-Zoom is adaptable to any conventional small-tube television camera. It weighs 4.5 lb and measures $8\frac{1}{4}$ in. long $\times$ $6\frac{1}{2}$ in. in diameter.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The E.D.L. Company offers services in the design and fabrication of magnetic recorders, video recorders, special purpose printers and light sources—and high production film process machines for all color and black-and-white processes. Specialists in the design and construction of high temperature spray processing machines.

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**The Servotherm UV-IR Photometer Model 1370,** designed to counteract meter errors due to temperature changes, blanket film speed ratings, fixed field of view and low sensitivity, is a portable instrument for measuring radiation in selected spectral bands corresponding to various specific film types and covering a range of 0.3 $\mu$ to 3.0 $\mu$ (UV, visible and IR). Since film response and correction filters are internally duplicated, direct stop and shutter speed

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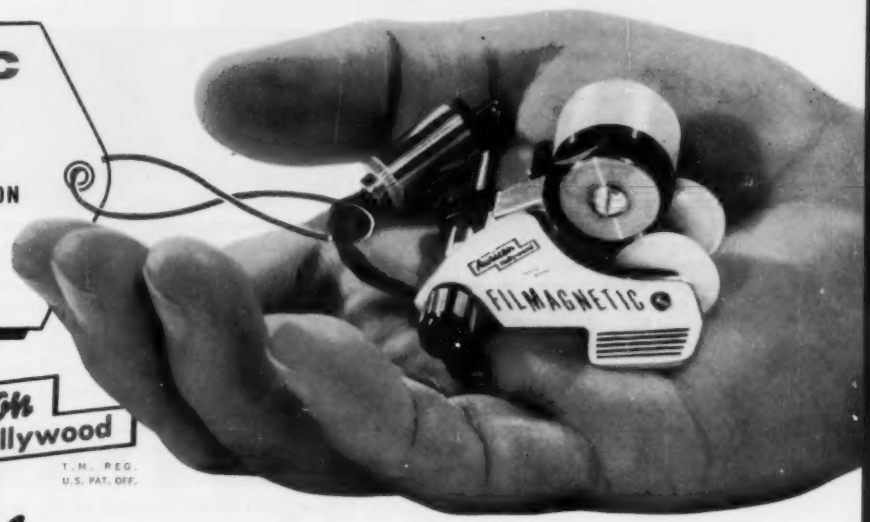


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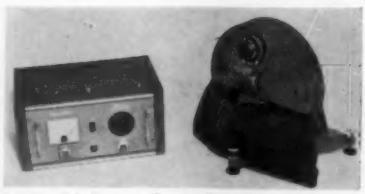
readings eliminate scale changes, tables and computations. Selective fields of view (7° to 50°) permit distant measurement of the entire picture or specific highlights. Self-powered, the UV-IR Photometer is "transistorized." Operating at any altitude, it is said to be independent of ambient temperature variations, and may be mounted on either tripod or hand grip. The shutter speed scale ranges from 1/1600 to 1 sec. The *f*-stop scale ranges from *f*/1.5 to *f*/64. Radiation intensity range is 30,000 to 1 (in two stages); ambient temperature range is −20 C to 40 C. Further information may be obtained from the manufacturer: Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L.I., N.Y. (W. K. Schoonmaker, FIeldstone 7-2810).



**A new high-speed rotating drum camera, Model 224,** has been developed by Beckman & Whitley, Inc., 945 E. San Carlos Ave., San Carlos, Calif. A general-purpose research camera, it offers the range of high writing speeds from 4 to 400 ft of film/sec. Accessories available permit its use as a streak camera, or, using a pulsed-light source, as a framing camera. Used in conjunction with the Beckman & Whitley Model 189 Framing Camera, it provides a greatly extended total framing time but retains the short exposure time of the latter.

The drum of 50-in. circumference carries film on its inside cylindrical surface. A turret-mounted 45° first-surface mirror orients the optical axis perpendicular to the plane of the drum. When driven by its electric motor at speed up to 6,000 rpm, the camera provides 10 msec of writing time on the 35mm × 50-in. film.

In operation, the drum is brought up to constant speed, and an electrically operated capping shutter is opened when it is desired to make the exposure. The shutter remains open during one complete revolution of the drum. Electrical contacts, synchronized with the operation of the shutter blades, are provided to actuate short-duration events through secondary electrical circuits.

The control unit provides all the necessary controls for safe operation of the camera. This includes a continuously variable voltage regulating system which handles input to the 1-hp 115-v 60-cycle motor. A contact-type voltmeter on the panel indicates the regulating voltage and limits the drum to its maximum speed of 6,000 rpm. An electronic tachometer is also available for accurate display of drum speeds.

The camera can be rotated through 360°. A bore-site focusing eyepiece is included and a film-changing bag is available for daylight loading and unloading of film.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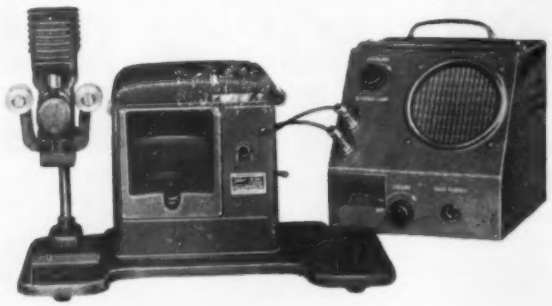

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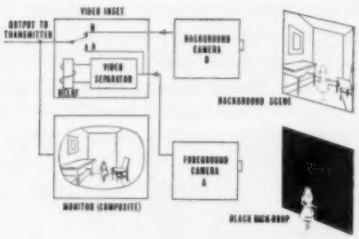


**Color Video Inset** was developed by the National Broadcasting Company to facilitate small studios' production of spectacles and of special effects. It was developed by the NBC Engineering Dept. under the supervision of the late Robert E. Shelby, Vice-President and Chief Engineer.

The color video inset, which permits the image from one camera to be set into the image from another to form a single picture, was first used in the Maurice Evans production of *Alice in Wonderland*, on October 23. In one scene, Alice seemed to shrink in size while she was on-camera. This was accomplished by reducing her image as picked up by the foreground camera, while leaving the scene from the background camera unchanged. In another scene, an image of a troupe of dancing oysters was inserted in the Walrus-and-Carpenter sequence.

An advantage of the system is that it permits the foreground of the picture to be controlled independently of the background. As shown in the diagram, one camera scans a background scene, and the other scans the inset object, which must be placed against a black backdrop. An electronic mixing device automatically records a silhouette of the inset object, then cuts a correspondingly shaped hole in the background and makes the insert. The process

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requires precise control in production work as well as in electronic timing, which must be accurate to one-tenth of a microsecond.

The effect of the inset, unlike that of the television superimposition, is to present a solid picture, without overlapping. In this respect, the color inset is similar to the matting process in film which requires complex lighting and processing work. Thus the inset will permit the instantaneous use of live camera effects which formerly were possible only with the use of processed film.

NBC is now working on a further extension of the inset principle, using three cameras to produce an inset within an inset. The color video inset, like the black-and-white video inset, has been produced by the Development Group of the NBC Engineering Dept., which interprets and adapts RCA's laboratory research to the broadcasting uses of NBC.

**Reid H. Ray Film Industries Inc.,** 2269 Ford Parkway, Saint Paul 1, Minn., has issued a 20-page booklet giving a very concise description in pictures and few words of the 45-year old firm's complete motion-picture production organization. It shows some of the firm's 110 employees on locations throughout the nation or at work in these departments under one roof: script, animation, sales, service, screening, studio stage, sound, stills, processing laboratory, and editing. This booklet is well planned and well printed.

**PrograMaster** is a new crawl and special effects machine for continuous-travel TV program credits, commericals and films for use in open and closed television circuits. Remote electronic control produces a steady travel of film with adjustable speeds that can be varied even while film is in motion. The unit can be operated in either vertical or horizontal positions. The horizontal position is recommended for use in producing animation by passing murals behind scale models at a constant or a variable rate of speed. The system uses a direct, nonphotographic printing method to produce messages in line, halftone, shaded or color process.

Superimposition may be achieved without "bleed through" by the combined use of a single camera and the PrograMaster. The camera shoots a picture direct, while the message or other image, on transparent film, is simultaneously passed through. Designed for use in TV stations, film studios and agencies using closed circuit TV, the equipment is made by PrograMaster Co., 1 Waterman Ave., East Providence, R.I.

**Audio-visual materials and services** are readily obtainable in most localities of U.S. and Canada, according to a new "NAVA Membership List and Trade Directory" recently published by the National Audio-Visual Assn. The 24-page directory is issued to aid all who make arrangements for audio-visual presentations, projections service, rental or purchase of equipment, tape recordings of meetings, rental of 16mm films, and other audio-visual aids for conferences, sales meetings, exhibitions, schools, religious groups and others who make meetings appeal to both eye and ear.

The directory lists dealers by geographical location, with each dealer-listing coded to show where a user can rent or buy some 15 types of audio-visual equipment. Single copies of the directory are available free to users; address: National Audio-Visual Assn., 2540 Eastwood Ave., Evanston, Ill.

**Bronoptics Co.,** optical engineers, under the management of S. Davis Bronson, is now located at 4838 Van Nuys Blvd., Sherman Oaks, Calif. Bronoptics also represents the Ferson Optical Co., Inc., for consultation, setup, maintenance and testing. The facilities of Bronoptics Co. include: engineering, research, development and production of lenses, mirrors, prisms and other optical engineering needs.


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S.O.S., the "One-Stop Source" is celebrating its 30th anniversary..carries practically every conceivable need in Motion Picture & TV production equipment—an enormous stock, more varied and more complete than any in the industry. Listed are a few of the items that will be shown at the SMPTE Convention.

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- Moy Film Edge Numbering Machines
- S.O.S. Titler & Special Effects Kit
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- S.O.S. Body-Brace Camera Pod
- Tel-Animaprint Hot Press Title Machine
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- Acme Animation
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- Blue Seal 35mm Recorders
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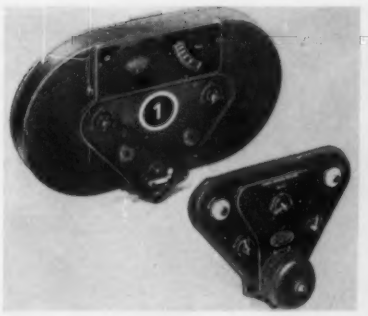
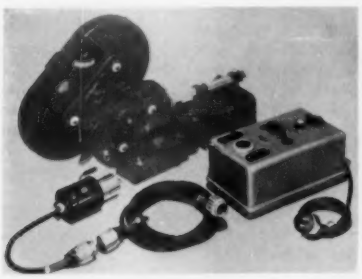


**Three new accessories** for the Arri 16 are a 400-ft film magazine, a synchronous motor, and an animation motor.

The 400-ft film magazine is of a very compact, single-compartment displacement type. It accommodates 400-ft darkroom loads (on cores) and 200-ft daylight spools. No belts are employed. A detachable torque motor, which interchanges for use with several magazines, drives the take-up through a gear transmission with the correct tension regardless of the amount of film on the take-up spindle. The torque motor operates on 6–8 v d-c and obtains its energy from the power supply used to operate the camera. Electrical contact is made automatically as the magazine is attached to the camera. The torque motor has a forward-reverse switch, corresponding to the forward-reverse feature of the Arri camera. Each magazine has a footage counter and is numbered for easy identification.



The synchronous motor is easily interchangeable with the variable-speed motor, supplied as standard equipment with the Arriflex. The light and compact synchronous motor can be used on the camera for hand-held shooting. The motor has its own 110-v, 60-cycle a-c supply. Output to the camera motor is 42 v, 60-cycle a-c, and to the torque motor on the magazine (when used) 8 v d-c.

The animation motor features $\frac{1}{4}$-sec exposures for either single-frame or continuous shooting at 60 frames/min. A built-on frame counter registers up to 4 digits. The animation motor can be used manually or with either foot-switch, relay or intervalometer. The unit operates on 100 v, 60 cycles, but can be converted to other voltages and frequencies on special order.

These accessories will be exhibited at the SMPTE Convention, April 30–May 4. Further information can be obtained from Kling Photo Corp., 257 Fourth Ave., New York; or 7303 Melrose Ave., Hollywood.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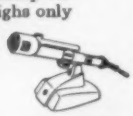

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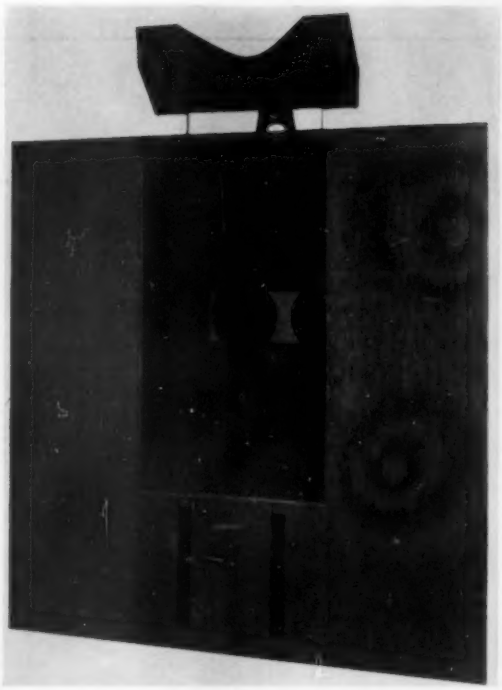
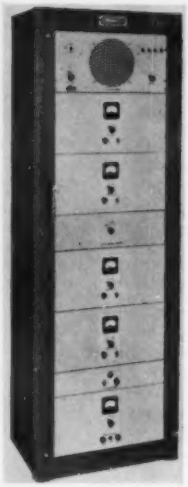




**Westrex Corporation,** New York, and its subsidiary companies with offices in 40 countries, have just announced to motion-picture exhibitors a complete new line of sound-reproducing equipments to meet the requirements of the recent technical developments.

The Westrex single-channel systems utilize the new major components of the multichannel systems and are designed to permit improving the sound in theaters not yet ready to convert to stereophonic sound. These single-channel systems can be expanded into multichannel systems.

The multichannel systems are composed of the following main units:

The Westrex R10 stereophonic reproducer operates with any modern projector to reproduce magnetic soundtracks. It has two impedance drums. An adjustable idler roller is provided to match the length of film path for different makes of projectors. A large 32-tooth sprocket controls the film on both sides of the magnetic head. A 4-track magnetic reproducer head is mounted on a separate plate which may be removed and replaced with a head assembly of fewer tracks if required.

The Westrex R6 photographic sound reproducer features the special timing belts which are used in high-quality studio recording systems. These belts do not slip or stretch and are noiseless in operation. The R6 has been designed with a longer optical path and an equilight diffuser to assure the best reproduction from either variable-area or density soundtracks.

The 51B multichannel magnetic preamplifier cabinet is wall mounted and contains up to four preamplifiers, control amplifier, low-pass filter, change-over and muting relays for multichannel magnetic reproduction.

The 52A multichannel control cabinet is wall mounted and contains the control equipment for single and multichannel as well as nonsynchronous and emergency operation. A three-gang volume control is provided for the backstage channels and a single control for the auditorium surround channel.

The Westrex multichannel floor cabinets house up to four 27-type 60-w power amplifiers with their associated power supplies. These cabinets have self-contained monitoring, nonsynchronous, and switching facilities. The Westrex switching includes facilities which enable the projectionist to test each channel independently and in the event of failure in one channel to operate through the other two channels behind the screen or, if desired, through the center single channel.

The Westrex 27-type 60-w power amplifier with its new circuits and specially wound coils has been designed to deliver more output with less distortion and with the use of less current with standard vacuum tubes than with any previous 60-w amplifier. Tubes used in this amplifier are obtainable from ordinary commercial sources.

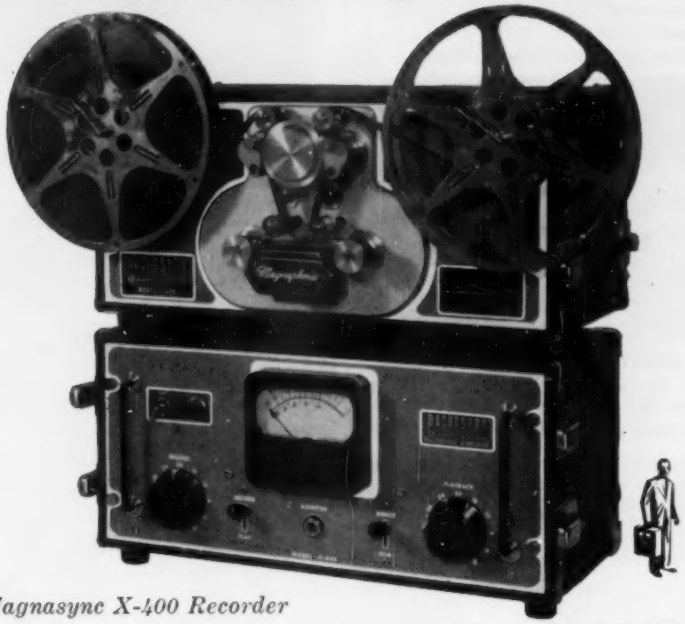
The 48A single-channel control cabinet is small in size and may be wall mounted.

The Westrex 49-type transmission cabinet for the single photographic system has all controls specially mounted and designed for easy access.

The Westrex type 16 loudspeaker assembly with associated high- and low-frequency units, baffles, and dividing networks was designed for increased efficiency and smoother performance to meet current and future exacting requirements of the multi- or single-channel sound. The Westrex sound systems feature the acoustic lens high-frequency horn. This acoustic lens assures an even distribution of sound throughout an auditorium with an absolute minimum of interference patterns. The high-frequency horns are available for either 50° or 80° horizontal coverage.

*a complete*

**27-lb. sound system!**



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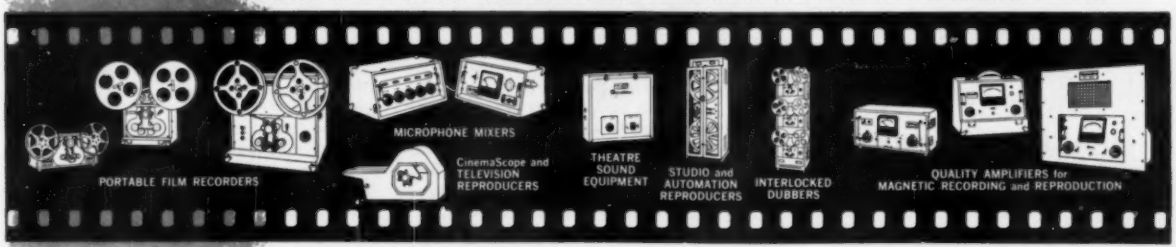


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CHICAGO—Zenith Cinema Service, Inc., 3252 Foster Ave., Chicago 25, Ill. IRving 8-2104.

SAN FRANCISCO—Brooks Camera Co., 45 Kearney St., San Francisco, Calif. EXbrook 2-7348.

CANADA—Alex L. Clark, Ltd., 3745 Bloor St., Toronto 18, Ontario. BEImont 1-3303.

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The unit features built-in variable equalization for special effects; continuously adjustable reverberation time; and no pressure pads—resulting in better tape motion and reduced head wear. Size is 17½ × 19". *Price is $1375.00.*

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**A new John Oxberry-designed process camera,** a combination of 35mm and 16mm, for animation and optical printer work, is being marketed by The Animation Equipment Corp., 38 Hudson St., New Rochelle, N. Y.

Conversion from one size to the other is effected in five minutes by changing the lens, shuttle, sprocket assembly and magazine. Use of one camera for both film sizes circumvents critical realigning required when two cameras are employed on an animation stand or optical printer. The camera may be bought for use with only one size of film, and accessories acquired later for the other size.

The camera has a shuttle-type movement with fixed pilot-pin registration. It has a rack-over mechanism for animation work. A socket drive accommodates portable and stationary stop-motion motors.

A hand dissolve mechanism on the front of the camera has a linear scale calibrated in 16 frames and 24 frames for cross dissolve (DX). The shutter may be set and locked at a designated opening such as ¼ shutter, ½ shutter, etc. Shutter opening is 170°. An automatic dissolve is operated through a dial selector on the side of the camera and has a range from 8 to 80 frames. A two-position switch controls and indicates shutter position as to DX-in or DX-out.

The front of the animation camera takes 35mm or 16mm Oxberry lens mounts. There are two available: one for hand-focusing is calibrated in feet and inches; the other is for automatic follow focus.

On the rack-over camera for 35mm film, a 47mm focal-length lens is used. A 25mm focal-length lens is employed for 16mm film. On the rack-over camera, the shortest back focus of any lens cannot exceed 1 7/32 in.

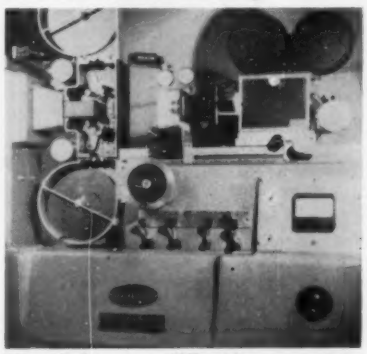
Two rack-over systems are provided on the Oxberry camera. One is operated by a lever which activates a no-shock movement that aligns the viewfinder directly over the lens. The other rack-over is controlled by an indexing knob which accurately shifts the camera to the correct location for sound on left or right and for exact center for film strip. The reason for this is that the camera goes forward for live action direction in work with puppets and miniatures, whereas it operates in reverse for animation.

The rack-over viewfinder with ground glass focusing is mounted on the hinged-door side of the camera. The eyepiece faces the operator when the camera is on the animation stand. A new optical system rectifies the subject so the image is erected and copy may be read from left to right.

The superimposure viewing device facilitates composing and focusing. It has a reticle plate and two registration pins which are identical with those of the shuttle. This permits a frame to be located precisely on a designated section of the animated or projected image in conjunction with cross-haired ground glass. The image plane of the film when racked-over is the same as the film plane in the shuttle. When a light is placed in the eypiece, the image may be projected onto the compound. A thumb slide shifts the viewfinder up and down changing the magnification for 16mm work.

An outstanding feature of the new camera involves the 35mm–16mm reticle design. All reticles are mounted in ground steel dove-tail plates having super-fine ground glass precisely mounted and aligned to match the film registration pins. All Oxberry reticles are interchangeable and are available on clear glass for projection of light. The reticle gauge plate may be used as a visual gauge for viewing alignment and for center or squareness of developed negative stock. By holding the reticle gauge over any light source, a film that is mounted on pins may be checked visually.

For optical printer installations, the Oxberry camera is essentially the same except that it is not the rack-over type. The superimposure device is mounted in front of the shuttle for reflex viewing.



**One of the great difficulties,** created by the still-growing use of 16mm in addition to 35mm film has been the need for intermediate dupe-negatives, for the production of dissolves, fades, wipes, superimposures and other optical effects. This problem has been solved by C and G Film Effects of 1600 Broadway, New York 19, which now has in use a new optical printer which in one fast operation produces all kinds of opticals from 16mm, 35mm or mixed originals, to give the producer either 16mm or 35mm optical dupes. The system eliminates the intermediate duping which was needed in the past to bring 16mm originals up to 35mm for optical printing, before reducing the resulting effect to 16mm again.

The new printer, supplied by Animation Equipment Corp., also has controls which make it possible to slow down or speed up action by an automatically controlled print-skip-print or print-freeze-print attachment. This too operates in both 16mm and 35mm and among other uses, makes it possible to transform footage shot at silent speed to a new negative, usable with sound. So far as is known, this is the first optical effects printer of its kind, and initial test runs have been beyond original expectations.

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# employment service

**These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.**

## Positions Wanted

**16mm Cameraman.** All phases of 16mm and 35mm motion picture photography. Also film strip production and industrial still photography. Have own equipment for both motion picture and still. Would like position with studio or industrial concern in New York or New Jersey. Leslie Crocker, 24 Brookwood Dr., Maplewood, N.J.

**Film Buyer or Sales.** Ten years experience in industrial films. Desire position in Italy. Resume on request. Write: Fred Forma, 8798 16th Avenue, Brooklyn 14, N. Y.

**Processing Lab Technician.** Seven years with Kodak in Kodachrome processing stations, plus 5 years prior work in stills. Now with small N.Y.C. lab doing quality control and technical service work. Experienced in chemical analysis, solution control, printing and duplicating B & W and color, Eastman Kodak and Ansco materials, including Eastman Kodak positive-negative color, maintenance, construction, production, planning. Charles J. Gudtner, Apt. 225, 611 West 112 St., New York 25.

**TV Operations Man.** Knowledge of remotes. Free to travel. Desires position as studio technician. Civilian and Armed Forces radio and TV trouble-shooting experience. Knowledge of film work lab. TV Workshop and Cambridge School graduate. Write: Philip R. Smith, 2914 Gerber Place, Bronx 65, N. Y.

**Cameraman—Director.** Married, formerly in charge of motion-picture dept. of large metal producing company. Ten years experience in various phases of film, television and visual aids production. Desires position with organization in eastern U. S. Illustrative resume sent upon request. Vitaly V. Uzoff, 611 West 141 St., New York 31.

## Positions Available

**Mechanical Design Engineers—Senior Grade.** Openings immediately available. Basic knowledge of the professional motion-picture production cycle necessary, with specific emphasis on laboratory functions. A knowledge of 16mm and 35mm printers would be helpful, but is not required. For interview telephone AM 2-1600 or wire to George L. Oakley, c/o Bell & Howell Co., 7100 McCormick Rd., Chicago 45.

**Motion Picture and Still Photography.** Growing producer in South has excellent opportunity for experienced man. Must also have editing experience. Give resume and references in first letter. Continental Productions Corp., 539 Vine St., Chattanooga, Tenn.

**16mm Laboratory Technician** to take over operation and responsibility of reversal processing laboratory. Must be capable of taking full charge; know emulsions and chemicals, and maintenance of Houston Model 22 machine; and capable of growing with expanding studio. Experience in printing both color and black and white desired. Write full resume, references and salary requirements to Joseph Dephoure, Dephoure Studios, 782 Commonwealth Ave., Boston 15, Mass.

**16mm Processing Technician.** Excellent opportunity for top-notch man; must be neat, orderly, accurate and possess knowledge of photographic chemistry. Send resume of background and experience to Eugene F. Fischer, Fischer Photographic Laboratory, Inc., 1731 N. Mobile Ave., Chicago 39, Ill.

**Motion Picture Assistant.** Need young man, graduate college-level motion-picture production course, to assist in all phases production in industrial motion-picture unit. Send complete resume and references including salary requirement to Salaried Personnel Dept., Ford Motor Co., 3000 Schaefer Rd., Dearborn, Mich.

**Motion-Picture Unit Director.** An unusual opportunity for man to organize and direct a motion-picture unit. He must have experience in animation, slide films and motion pictures. He must be familiar with all types of motion-picture equipment and sources and be able to guide others in the development and execution of industrial training films. Location: St. Louis, Mo. Write, giving full history, with photo, and stating salary required, to: P.O. Box 754, Colorado Springs, Colo.

**16mm Laboratory Technician** for position as lab supervisor in a growing motion-picture laboratory. Must be thoroughly experienced in control and processing of 16mm films, both black-and-white and color. Salary and percentage to man who can qualify. Send resume, references and approximate salary requirements to: Western Cine Service, Inc., 114 East Eighth Ave., Denver 3, Colo.

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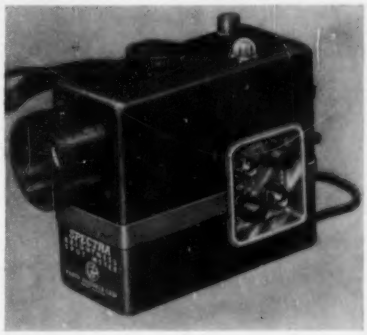

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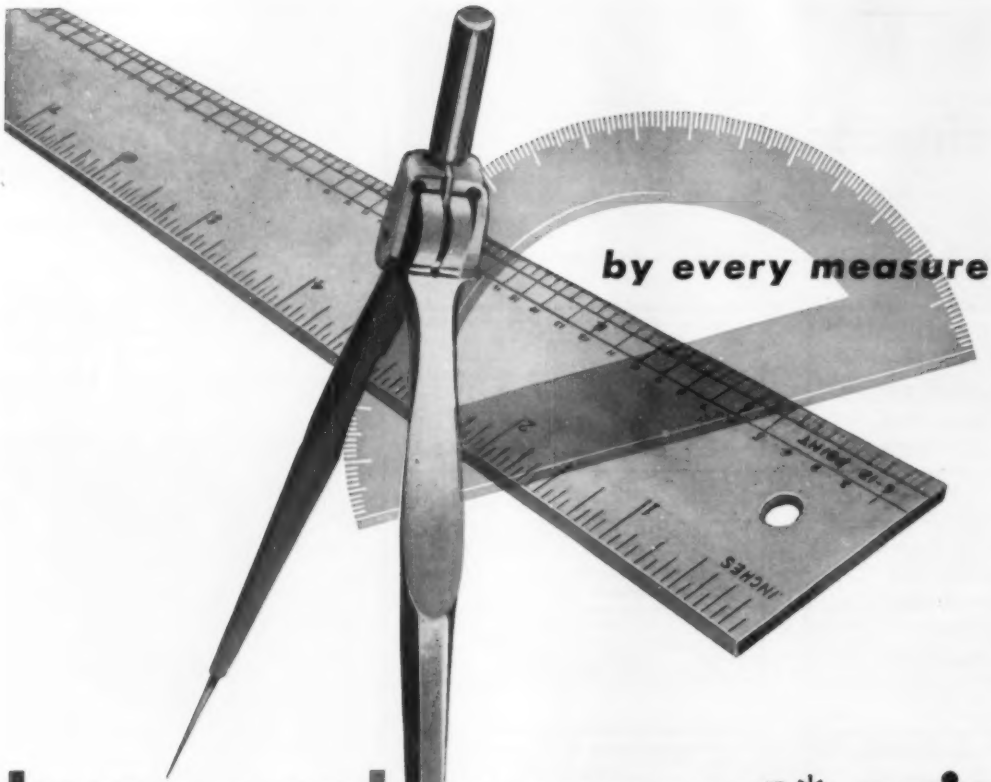


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### Meeting Calendar

Optical Society of America, April 5–7, Bellevue-Stratford, Philadelphia; Oct. 18–20, Lake Placid Club, Essex County, N. Y.; Mar. 7–9, 1957, Hotel Statler, New York.

**SMPTE Central Section, Apr. 16, May 21, June 18**

International Symposium on Nonlinear Circuit Analyses, II; sixth of a series sponsored by the Polytechnic Institute of Brooklyn, Apr. 25–27, 1956, Engineering Societies Building, New York.

**79th Semiannual Convention of the SMPTE, including Equipment Exhibit, Apr. 29–May 4, 1956, Hotel Statler, New York.**

ASME-Engineering Institute of Canada Joint Meeting, May 23–25, 1956, Mount Royal Hotel, Montreal.

National Audio-Visual Convention, July 20–25, 1956, Hotel Sherman, Chicago.

Western Electronic Show and Convention, Aug. 21–24, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles.

Biological Photographic Association, Aug. 27–31, Powers Hotel, Rochester, N. Y.

High-Speed Photography, Third International Congress, including exhibit of high-speed photographic and cinematographic equipment and instrument aids; sponsored by Britain's Dept. of Scientific and Industrial Research, Sept. 10–15, 1956, London.

American Society of Mechanical Engineers, Sept. 10–12, 1956, Denver.

Theater Owners of America, Inc., Annual Convention, Sept. 19–25, 1956, Coliseum, New York.

National Association of Educational Broadcasters, Oct. 1956, Atlanta.

National Electronics Conference, Inc., 12th Annual Conference, Oct. 1–3, 1956, Hotel Sherman, Chicago.

**80th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 7–12, 1956, Ambassador Hotel, Los Angeles.**

Ninth Annual Conference on Electrical Techniques in Medicine and Biology, Nov. 7–9, Governor Clinton Hotel, New York.

**81st Semiannual Convention of the SMPTE, Apr. 28–May 3, 1957, Shoreham Hotel, Washington, D.C.**

**82nd Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 6–11, 1957, Hotel Statler, New York.**

**83rd Semiannual Convention of the SMPTE, April 20–26, 1958, Ambassador Hotel, Los Angeles.**

**84th Semiannual Convention of the SMPTE, Oct. 19–24, 1958, Sheraton-Cadillac, Detroit.**

**85th Semiannual Convention of the SMPTE, May 3–8, 1959, Fontainebleau, Miami Beach.**

**86th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 5–10, 1959, Hotel Statler, New York.**

**SMPTE Officers and Committees:** The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members were published in the April 1955 Journal.

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